Farm Crops

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PREFACE.

AGRICULTURAL education has become one of the topics of the day, although there is evidence that its precise limits and scope are not yet grasped. It is therefore necessary, in submitting the following pages to the public, to indicate my aim in writing them. The whole subject of Agriculture is so vast that an exhaustive treatment was at once seen to be impossible. It was also suggested that the work should be limited in extent, and penned in the plainest possible language, and hence I was restricted both as to the use of words and terms.

It also appeared desirable to avoid long descriptions of processes and methods which would be calculated to weary the mind rather than to excite interest. The book is not meant to serve as a guide to farmers, but as an introduction to those questions, and that particular kind of information, which must in the end be of use to a bailiff or a farmer. How to present the principal facts regarding farm crops to children in elementary schools without degenerating into vagueness, or, on the other hand, becoming prolix, was no easy task. It is more difficult to write for the ignorant than for those who are already familiar with a subject. Even the most ordinary expression, such as drilling, broadcasting, horse-hoeing, cultivating, etc., however familiar to a farmer or carter, do not carry a definite meaning to the minds of children, and must be

used carefully and after due explanation. Hence it will be seen that the very word "crops" is explained before dealing with crops and their divisions and uses. Similarly, the meaning of "rotations" is given before dealing with rotations; and, again, in introducing clover as a crop, the pupil is informed that there are many kinds of clovers.

Although simplicity has been preserved to the best ability of the author, it will be found that most of the questions relating to crop cultivation are discussed in such a manner as to awaken interest, and to lay a foundation for deeper knowledge; and this has, in fact, been my principal object.

The ordinary crops are alone treated of, and some apology may be necessary for leaving out of consideration several important crops, such as the potato, for example. The prescribed limits of the work furnish the most evident excuse for their omission. The potato is unquestionably an important farm crop, but it does not necessarily enter into the most usual rotations. The relations between fodder crops and corn crops can be best shown without the intervention of potato cultivation, and the many varieties of potato and the details of the cultivation would necessarily have led to the occupation of much space. Again, the potato belongs more properly to the garden, market garden, or to favoured soils, and is not to be seen growing on the open wold or wide stretches of agricultural land on the chalk, the oolites, or, in fact, on the generality of moderately fertile soils.

The subject of "grasses" is of great interest, and is one of those to which attention ought specially to be called. The term grass is too often accepted as including all the

plants which constitute a pasture or meadow, and it is necessary that the differences between the various kinds of grasses and clovers should be thoroughly and clearly explained. This important matter has been ably dealt with in a chapter by Dr. Freame, who has paid great attention to the subject, and has presented it in a simple and plain manner, in harmony with the general intention of the work. In future editions this little book may, no doubt, be further extended, but it may, I trust, even in its present form, be accepted as an honest attempt to place the large subject of crop cultivation before the minds of children in a sound form, and in a manner which will suggest the many points which good farmers find it necessary to consider in carrying out their operations.

JOHN WRIGHTSON.

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FARM CROPS.

CHAPTER I.

INTRODUCTORY.

THE "CROPS," AND THEIR VALUE.

If there is oue thing more than another which is spoken of among neighbours in the country, it is the state of the crops: whether the season is suitable or unsuitable for the crops, or if they are going to be light or heavy, blighted or healthy, late or early. These questions form the staple of conversation when country people meet each other, from which we gather that the crops are exceedingly important.

The more we study crops, the more important do they appear to be. This is because we depend upon them for our food. At one time the failure of the crops meant famiue, and although we do not now fear such a result in Englaud, or in most of the couutries in Europe and America, famines still occur in less civilised countries when the crops fail. The last occasion on which we suffered from famine in these islands was in 1846, when the potato crop failed in Ireland, and tens of thousands of people were starved to

death, and the country lost millions of its population through the emigration and distress which followed.

FOREIGN CROPS.

The reason we do not now fear famine when the seasons are unfavourable is principally to be found in the invention of steam-ships and the cultivation of vast tracts of land in America, Australia, and India, from whence inexhaustible supplies of food are brought to our shores. Still, although the failure of our crops is less to be feared than formerly, a bad season is looked upon as a great national disaster, and a good season as a great national blessing.

What we mean by "the Crops."

Under the term crops we not only include field, but garden produce; and as butcher's meat is produced from the consumption of grass, hay, and turnip-crops, it also is properly considered as the produce of the land. So also our supply of milk, cream, cheese, and butter is dependent upon the successful growth of grass and other green crops, and hence, on looking at a breakfast or a dinner table well supplied with eatables, we see the produce of our own fields and gardens.

We are, however, indebted to the crops of other countries besides our own, and very little thought will convince us of the fact that we not only owe our food, but our clothing, and most of our luxuries, to the crops of the various countries of the world. It would take too long to enumerate all the crops which we employ every day in our complicated system of living, but a few may be mentioned in order to show the relation which subsists

between our comforts and "the crops." First, then, there are the solid necessaries of life: bread, bacon, butter, cheese, milk, beef, mutton, potatoes, and vegetables. Beer is also a home product, and, as everybody knows, is prepared from barley. We therefore can picture a table well furnished with wholesome food and drink, all produced from the fields and gardens around us.

What we owe to "the Crops."

But we must look farther if we want to see the full importance of crops. We must glance at the tables of the wealthy as well as of the humble, and there we shall see many things which are rather to be classed as luxuries than as necessaries of life.

These are, countless seasonings and essences for flavouring, costly wines, liqueurs and spirits, choice fruits for dessert. Neither must we forget those necessary articles of food, tea, coffee, cocoa, rice, sago, arrowroot, sugar, etc., which are imported from warmer countries than our own, but which are none the less produced from crops. Another class of cultivated crops yields drugs, such as senna, rhubarb, opium, tobacco, castor-oil, quinine, etc. Neither is the subject yet exhausted, for the importance of crops does not cease with food and medicine, but extends to clothing also. It is only necessary to mention wool, cotton, linen, and silk, all of which are grown by farmers or cultivators at home and abroad, to show that we depend upon certain crops even for our clothing. Many dyes are also grown as crops, such as woad, weld, madder, and indigo.

Sufficient has been said to show that crops in one form or another are of high importance and interest to every

one, but it is not possible to treat of all kinds of cultivated plants in a small book like this. We shall rather endeavour to impart some useful information upon the various crops cultivated in our own country. Many of them are familiar to us all, and my young readers are no doubt accustomed to look upon fields of wheat, barley, and oats, turnips, mangel-wurzel, and potatoes, besides many other crops which take their place in our fields.

The Lessons we have to learn.

It is, however, necessary to know a great deal about crops before they can be successfully or profitably grown. A good farmer or bailiff, or even an intelligent labourer, must know a great deal, not only about crops, but about the animals which consume them, and the instruments which are used in their cultivation, their harvesting, and their preparation for market. He should also be able to form a good judgment as to the descriptions of soil most suitable for different crops or varieties of crops, the right season of the year to sow them, the proper preparations of the soil, the quantity of seed, the distance apart and the depth at which to deposit the seed, the manuring of the crop, and a great many other things besides, which it would be tedious to mention at present. Then there is the study of the diseases and the insect attacks to which crops are subject; and finally, there is the preparation for market, and the question of cost, and profit or loss.

Nearly all that can be known about cultivated crops is included in the following list, which ought to be carefully read and impressed upon the memory of every one who wishes to be a good farmer. It will be seen to be divisible

into, first, some points of general interest; secondly, into various matters connected with the actual cultivation of crops which succeed each other in order of time; thirdly, into certain subjects which almost naturally occur to the inquirer seeking for full information.

SYLLABUS OF THE ENTIRE SUBJECT OF CROP CULTIVATION.

General Considerations.

1. Position in the Vegetable Kingdom, and relations to wild forms still uncultivated.
2. History and origin.
3. Varieties.
4. Place in a rotation of crops.
5. Soils and situations most suitable for its full development.

Chronological Order of Events in the History of a Crop.

6. Preparation of the ground for the reception of the seed, plant, tuber, or root.
7. Season of the year for sowing.
8. Methods of sowing.
9. Quantity of seed, tuber, or root.
10. Manuring.
11. After cultivation (weeding, hoeing, etc.).
12. Ripening or maturing.
13. Harvesting or securing.
14. Preparation for market or for home use.

Concluding Considerations.

15. Insect enemies and insect friends.
16. Diseases, and remedies or preventive measures.
17. Nutrient or feeding properties, and composition.
18. Cost of production and probable yield or amount of crop.

It will be at once seen that these eighteen sections must necessarily call out various views, as some farmers prefer one method and some another. Each section also may be further subdivided; as, for example, **Methods of Sowing** will lead us to speak of

Broadcasting, or the scattering of seed by the hand.

Drilling, or sowing in rows by a machine.
Dibbling, or depositing one or more seeds in holes made by a dibbling-stick.
Ploughing in, or sowing upon the surface and then ploughing the seed under.
Transplanting from seed bed;

or under the heading of **Harvesting** or **Securing**, such subjects as the various methods of cutting, carting, and stacking corn; pulling mangel, and clamping, or storing root crops and potatoes, would be properly considered. When this very formidable list of topics is applied to each of the field crops it will be found that a vast amount of time and labour will be required to master it; and yet this is not one half or one quarter of what a good farmer ought to be perfectly familiar with, for he has to do with men, with animals, with dairying, and with implements, as well as with crops.

The Value of "Book-learning" to the Farmer.

If any young farmer raises the objection that he is sure his father never troubled to learn such matters out of books, he may be reminded (1) that country people, even if they do not read, are always comparing notes upon such matters and talking about them; (2) that his parents, grandparents, and neighbours have often been settled for generations in the same village or on the same farm, and that a great deal of valuable knowledge must have come down almost unconsciously from father to son; (3) that if a young man hopes to occupy a responsible post and to improve his position in the world, it is very desirable that he should have clear, well-arranged information, and that he himself should be able to judge from his knowledge

of principles, whether what he is told is reasonable and true.

There is a great deal of ignorance and even of superstition abroad, and many practices might well be abandoned as useless. The man who has received correct instruction will be able not only to throw aside useless and injurious practices, but also to suggest improvements.

Without further preface we shall proceed to speak of the various crops, and show practically how the list of subjects above given may be expanded and filled up with facts relating to each of them.

THE VARIOUS CLASSES OF CROPS.

First Class: the Cereals.

All crops are easily divided into four groups.

First, **Cereal**, or white-straw crops, including wheat, barley, oats, and rye. There are many other cereals besides these, such as rice, maize, millet and sugar-cane; but they are only cultivated in tropical countries, or in those which enjoy a much higher summer temperature than we are favoured with in Great Britain and Ireland. The cereals are all true "grasses," and are similar in their nature to many plants which grow in our pastures and meadows, or upon commons and roadsides; they flower and fruit upon the same principle, and their leaves are long and narrow. They have only one seed leaf within the seed, and when they sprout they send up a single blade, and hence are spoken of by botanists as **Monocotyledons.** Most seeds contain two little leaves or lobes, and are, therefore,

called **Dicotyledons**, or plants with two cotyledons. Wheat and turnips may be taken as instances of these two different classes of plants.

Second Class: Fodder Crops.

Secondly, **Fodder** crops, which include a number of plants very dissimilar from each other, and belonging to widely separated classes or orders. Some are true **Grasses**, such as rye-grass, meadow foxtail, cocksfoot, and others, some of which are grown mixed, while others are cultivated separately.

The **Clovers** are members of a different order, and form another distinct group of fodder crops, including several kinds or species, all of which have three leaflets upon each leaf stalk, which gives them their generic or family name, Trifolium. Closely allied to the clovers are Trefoil or Black Medick (*Medicago lupulina*) Lucerne (*M. sativa*), Sainfoin (*Onobrychis sativa*), Kidney vetch (*Anthyllis Vulneraria*), Birdsfoot trefoil (*Lotus corniculatus*), and other plants of the order known as **Leguminosæ**, or plants which bear their seed in pods like peas. Fodder crops are usually understood to include any plant which is grown for its leaves for forage, and therefore we find vetches, rape, mustard, cabbages, and kales ranked under this class. There are also some plants belonging to the order **Umbelliferæ**, a class of plants which carry a number of flowers on little stalks all springing from one point in the main stem, which is generally hollow. Such are carrots, parsnips, parsley, celery, etc.

By far the larger number of our fodder crops belong

to the three natural orders: **Leguminosæ**, or podded plants, **Cruciferæ**, or cross-bearing plants, whose flowers take the form of a cross, as in cabbages, turnips, and mustard, and **Gramineæ**, or grasses.

Third Class: Root Crops.

Thirdly, there are the **Root** crops, distinguished as a group from the fodder plants by being consumed in the winter, and by their compact globular roots containing a large proportion of water but abounding also in sugar and other nutritious matters. The root crops include turnips, swedish turnips, mangel-wurzel, carrots and parsnips. Potatoes are sometimes classed with them, although improperly so, as they are grown for sale, whereas the other roots mentioned are grown for the use of cattle and sheep at home.

Fourth Class: Pulse Crops.

Fourthly, there is the small group of so called **Black**, or pulse crops, including beans and peas, and, according to some people, tares or vetches when grown for seed.

Crops and the Land they grow in.

The four groups of crops just enumerated produce different effects upon the land. This is partly due to their character, but in a greater degree to the methods of their cultivation and the uses to which they are put.

Cereals and the Land.

Cereals make the soil on which they are grown, poor, because they are sold off the land, and therefore carry away with them valuable materials which they have

extracted from the soil by their roots. They also allow weeds to grow unchecked, on account of the nearness of their rows to each other and the manner in which they occupy the entire surface of the soil. Cereal crops are allowed to occupy the ground for a longer period than fodder crops, and the weeds grow strongly and rapidly while they are ripening, as is often seen in the towering docks and thistles, knapweed and poppies, infesting fields of barley and wheat before harvest. Land cannot, in ordinary circumstances, be made to grow cereal crops year after year without becoming both poor and full of weeds.

Fodder Crops and the Land.

Fodder crops are considered to improve the land because they are eaten upon the farm or the field, and any materials they have taken from the soil in order to build up their substance are returned to the land in the form of manure by the cattle. A portion is no doubt retained in the bodies of the animals which eat them for the purpose of increasing their own weight, or in the case of dairy cows for making milk. The portion so retained is, however, very small, certainly not more than 4 or 8 per cent., and the remaining 92 or 96 per cent. is returned in the form of solid and liquid excrement. In the ordinary course of good farming these fodder crops are very frequently fed with allowances of purchased food, such as cake and corn, so that any loss of fertilising matter through absorption into the animal body for purposes of growth will in such cases be more than made up by the manure produced from the consumption of these extra foods. Fodder crops are cut and used as food when green, and with them the thistles,

docks, charlock, and other weeds which would otherwise ripen and shed their seed among the corn crops. They are bulky, close, or "smothering" in their habit of growth. Heavy crops of vetches or "trifolium" leave the ground free from weeds, or these are so stifled or weakened that they are scarcely visible. Hence, although most of the fodder crops are grown in narrow rows like the corn crops and do not allow of horse- or hand-hoeing, they are less likely to cause land to run wild or foul.

Roots and the Land.

"Roots," by which we mean chiefly the turnip and mangel crops, are relied upon to keep up and add to the fertility of a farm. They are very bulky growers, often producing a weight of thirty tons per acre, and in some cases double and treble that quantity. A crop which attains to such weights must be exhausting to the soil, and in fact much more so even than cereal crops. That this is the case the following figures will show.

WEIGHT IN POUNDS OF VARIOUS FERTILISING MATERIALS REMOVED FROM ONE ACRE OF LAND.

	By a crop of 30 bushels of wheat, exclusive of straw.	By a crop of 17 tons of turnips, exclusive of leaves.
Phosphoric acid	14·3	22·4
Potash	9·7	108·6
Lime	1·0	25·5
Sulphur	2·7	15·2
Nitrogen	33·0	71·0

All these substances have been taken out of the soil by the growing plants, and, except nitrogen, can be recovered by burning away the combustible portion. The white ash

which then remains will contain the whole of the phosphoric acid, potash, lime, sulphur and any other mineral matter taken from the soil.

How Turnips may exhaust the Land.

It will at once be seen that all the important fertilising materials in the soil are removed in much greater quantities by the turnip crop than by a cereal crop. As already pointed out, it is the destination of the crop, or the uses to which it is put, that really controls the exhaustion or the replenishing effect produced. The turnips are eaten by live stock upon the farm, and nearly all their constituent parts find their way back again to the soil. The turnip is also invariably eaten with additions of hay, cake, and corn, so that more fertilising matter finds its way back into the soil than was actually removed by the root crop. It will, however, be readily understood that a turnip crop sold off the farm is much more exhausting than is a wheat crop.

Beans and the Land.

Beans and peas are classed as corn crops because they ripen their seed and are, or may be, sold off the farm. They are less exhausting to the land than white-straw crops, and are often taken between two cereal crops; as, for example: first year, wheat; second year, beans; third year, wheat or oats.

CHAPTER II.

ROTATIONS OF CROPS.

Meaning of "Rotation of Crops."

Crops are grown in succession or rotation. Each crop of a rotation occupies the ground one year,* so that a four-course rotation runs through four years, a six-course through six years, and so on.

Uses of Rotations.

Certain crops are found to be especially suitable for preparing the ground for other plants. Thus beans and clover are good preparations for wheat; turnips fed upon the land are a good preparation for barley or oats, and grass is a good preparation for potatoes. On the other hand, wheat is a bad preparation for wheat, and as a principle it is not advisable to grow the same exhausting crop twice upon the same land. It is, however, good practice to grow two root or fodder crops in succession during two years following, because as they are eaten upon the land they produce a high state of fertility or richness in the soil. By this practice many poor or weak lands are enabled to produce heavy crops of corn.

We do not know who first practised a rotation or rational succession of crops, but it is certain that the soil itself would soon teach its cultivators that it could not

* When two crops are grown in one season, one of them is called a catch or stolen crop and is not considered to interfere with the orderly succession of the main crops.

go on producing one sort of crop for any great length of time.

Crops on new Soil.

It is true that when land is first broken up after it has been in the state of old natural pasture or forest, it is capable of growing many crops of wheat in succession, and cases have been known in America of land growing sixty crops without rest. This is due to the enormous store of fertility, which, however, is in time exhausted. In our own country this stock or store of plant food has long ago been used up, and a single corn crop is generally found to be sufficient, and requires to be followed by some crop which, by its consumption or feeding upon the land, restores its fertility.

If we take the case of a newly-discovered or newly-inhabited country like America, or an old pasture in our own country which has never been ploughed, the farmer may grow many corn crops in succession.

Rest required for the Land.

After a time, however, the stock of plant food in the soil will diminish until the cultivation of corn crops becomes unprofitable. After this stage has been reached the land will be found to require rest, and in the earliest and rudest times this rest would be given by leaving the field alone until it became naturally covered with grass. In course of time the soil would once more become fertile and bear another period of cropping with corn. Such an alternation of corn crops and grazing is still used in some places and gives an idea of rotation, although a

very rudimentary or simple one. The next step in advance is found in what is known as the **Fallow.** This is a very ancient system, as we read of it in the earliest books of the Bible. The Israelites were commanded to rest or fallow their land every seven years, just as the people were commanded to rest from work every seventh day. Our Anglo-Saxon forefathers fallowed their fields every three years, not having such productive soil or such a fine climate as Palestine enjoyed. The ancient Romans understood the value of a fallow or period of rest accompanied with tillage, and introduced the custom into Britain.

An ancient Rotation.

The oldest rotation worthy of the name is the three-year course, which runs as follows :—

1st year—Fallow.
2nd year—Wheat.
3rd year—Beans.

This rotation is said to date back to the first century of the Christian era, and to have been practised by the German tribes who conquered Rome and afterwards occupied our own country, and from whom we and all the northern nations of Europe are descended.

A modern Rotation.

A fallow every third year is, however, a great sacrifice on the part of the cultivator, who thus always has one third part of his land lying idle. On better classes of land an additional crop of oats or barley is taken, giving the succession of fallow, wheat, beans, oats, and limiting

the area under fallow to one quarter of the arable land. What is known as the Holderness rotation places fallows six years apart by the following course :—Fallow, wheat, clover, wheat, beans, wheat. This rotation is adapted for strong or stiff soils of good natural quality, such as that of the district of Holderness, on the south-east coast of Yorkshire.

During the last two hundred years great improvements have taken place in agriculture as in all other branches of industry. The bare fallow was found to be expensive because it required a vast amount of work without any immediate return; it meant repeated ploughings, harrowings and manuring without any return for two full years. It was also found that crops do not exhaust the land unless they are removed from it, and that if a crop is eaten upon the land by live stock, the soil is enriched. It was in fact discovered that land does not require rest so much as it needs manure or plant food to render it fertile, and that any crop which added to the stock of plant food was as good as, or even better than, a bare fallow.

The Value of Turnips in a Rotation.

Of all crops suited for the purpose of restoring fertility and taking the place of the bare fallow, the turnip, or root crops, are found to be the best. This is not because the turnip is not in itself exhausting, but because when used for fallowing purposes it is eaten upon the land by sheep or in fold-yards by cattle, and leaves fertility behind it in the form of sheep droppings or of a rich heap of farmyard manure.

The turnip, like all other plants, takes a large proportion of its substance from the air, and it also sends its roots deep into the ground, and brings up fertilising matter from below the cultivated soil—that is, from the subsoil. All this matter is thrown upon and mixed with the soil, which is thus enriched. Turnips and the other root crops are sown with wide spaces between the rows, and carefully hoed to keep them free from weeds during their growth.

Land, after roots, is therefore clean as well as rich, and these conditions are all that is necessary as a preparation for corn. One more point should be mentioned, namely, that the root crop enables the farmer to keep cattle and sheep through the winter; and as the maintenance of live stock has for many years been more profitable than corn-growing, the turnip-crop is of great value, and much superior to the old bare fallow, which returned nothing directly for the trouble expended upon it, except in the form of an improved state of the land for future crops.

The root crops have for these reasons taken the place of bare fallows in most localities, although not in all, as will afterwards be shown.

The Clovers.

Another series of crops which was introduced into our husbandry during the last century is Clover (Fig. 1). There are several sorts of clover, but we lay special stress upon the more free-growing species, red, alsike, and white clovers. The clover crop is usually sown, together with rye grass, under the name "seeds"—a term which probably is a short form of the phrase, "small seeds," by which is usually understood clover and grass seeds. These plants, like the root crops,

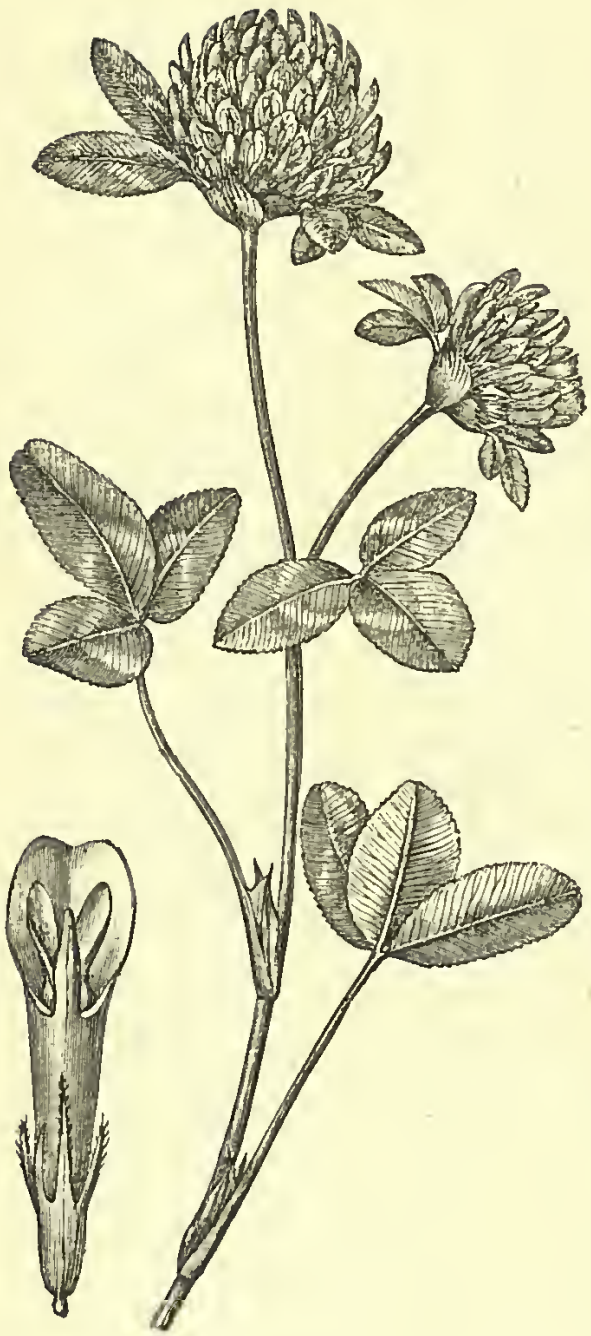


Fig. 1.—Clover.

are generally consumed upon the farm, but it is also equally important to us that the clovers are a specially good preparation for wheat.

It is now generally agreed that clovers and podded (leguminous) plants in general accumulate nitrogen in the soil, and that in two ways: first, by bringing it up from the depths of the subsoil — or under-soil — by their long and deep searching roots, and secondly, by obtaining nitrogen from the air. Clover, beans, peas, and vetches, all leave

the soil rich in nitrogen, and as this substance is the kind of food most required by wheat, it will be seen that clover must be a good crop to precede wheat. Wheat also prefers a firm and compact condition of soil, and this is ensured after it has been down in clover, and grazed by sheep for one or two seasons.

Four-Course or Norfolk Rotation.

The pupil will now be in a position to understand the beauty and the fitness of the four-course or Norfolk rotation of crops, which is generally followed, with modifications, upon most of the arable land of England. It commences with a root crop, under which the land is thoroughly cleaned and manured. This is followed by a corn crop—usually barley or oats, sown with clover and grass seeds. After the corn is reaped, the clover grows up and occupies the land for one year, and is either mown for hay or grazed, after which a crop of wheat is taken. Thus we form the four-course rotation, which may be briefly expressed as :—Roots, barley, clover, wheat.

MODIFICATIONS OF THE NORFOLK ROTATION.

These are very numerous, and occasionally the rotation becomes stretched into a five course, or even six course, without disturbing the general order of the cropping, as, for example, when clover is allowed to remain down two years.

In modifying the Norfolk rotation, the first change consists in the growing of one cereal crop instead of

another. The four crops named above as representing the rotation may be withdrawn, and others used without altering the general plan of the course. Thus oats or wheat may be taken the second year instead of barley, and oats may be taken instead of wheat in the fourth year. The rotation would then be—roots, wheat, seeds, oats; or roots, wheat, seeds, wheat;—and would still preserve its essential character of roots, corn, seeds, corn.

The Northumberland Rotation and East Lothian Rotations.

By leaving the clover or "seeds" down two years, and somewhat altering the order of the cereals, we obtain the Northumberland rotation, which is as follows: roots, wheat, clover, clover, oats. By growing potatoes as an additional crop in the rotation, the course of cropping assumes the character of the East Lothian system: roots, barley, clover, oats, potatoes, wheat. This, it must be admitted, is a rather wide departure from the Norfolk four-course, so that the East Lothian rotation may stand alone as a distinct system. The general principle will be seen to consist in an alternation of fallow or fodder crops with corn crops, and hence the four-course has sometimes been spoken of as an alternate system or two-course, which might be expressed as fodder, grain, fodder, grain.

Every crop in the rotation may be changed without breaking through this system of alternate fodder and corn. Thus, the term "roots" is just a little vague. Not only is it possible, but highly desirable, that the sort of root crop cultivated should be varied. The same remark applies to the cereals, and likewise to the clover portion,

for which may be substituted the growth of beans, peas, and other fodder crops.

The following rotations may be suggested as keeping up the general plan of the four-course rotation. It is a matter of common observation that land will produce a better crop the less frequently that crop is grown on the same situation. The more, in fact, that we can vary our cropping the better.

Normal 4-Course.
- 1st year—Turnips
- 2nd year—Barley
- 3rd year—Clover
- 4th year—Wheat

Modified 4-Course.
- 5th year—Swedes
- 6th year—Oats
- 7th year—Peas (dunged)
- 8th year—Wheat

2nd Modified 4-Course.
- 9th year—Cabbage or kale
- 10th year—Wheat
- 11th year—Clover
- 12th year—Clover
- 13th year—Oats.

Resting Land.
- 14th year—Turnips
- 15th year—Barley
- 16th year—Sainfoin
- 17th year—Sainfoin
- 18th year—Sainfoin
- 19th year—Sainfoin.

In the above, the principle of the Norfolk rotation is fairly followed for fourteen years, and yet no crop is taken too often, and in the fifteenth year the field is sown down with sainfoin, which may remain a few years before the land is again taken up for active tillage. It is not, however, by any means urged that the example just given of variations in cropping is to be followed out precisely.

The Wiltshire Rotation.

The general result of the Norfolk four-course rotation is that half the arable land is in corn and half in fodder. In parts of Wilts and Hants there is a plan of growing two

root crops in succession, followed by two corn crops, the order being:—Roots, roots, wheat, barley.

This system is well suited for light, thin, chalky soils, as the double cropping with roots is necessary to produce a really good crop of wheat, and the "condition" still left in the land after the wheat has been secured is enough to give a good crop of barley. The system allows of the early sowing of the barley, as there is no reason why the wheat stubble should not be ploughed up after harvest, ploughed a second time in winter, and sown with barley in February. Such a method is likely to result in a plump, larged sized barley, of good quality for malting; hence the system is widely practised and much approved. The cropping goes on during the next four years upon the plan of the Norfolk four-course, making in all an eight years' rotation which may be repeated as follows:—Roots, roots, wheat, barley, roots, barley, clover, wheat.

So much having been mastered, we may go a step farther in order to state that in this Wiltshire system there is yet another departure from the ordinary four-course rotation in the introduction of "catch crops" before the root crops. This is described as follows:—

1st year—Late fodder crops (vetches) fed off with sheep and followed with late sown turnips ...	Roots.
2nd year—Early sown turnips	Roots.
3rd year—Wheat	Wheat.
4th year—Barley	Barley.
5th year—Early fodder crops (rye, barley, or "trifolium") fed by sheep and followed with mangel and swedes	Roots.
6th year—Barley	Barley.
7th year—Clover	Clover.
8th year—Wheat	Wheat.

Rotations of Crops for Clay Soils.

In many cases little difference is made between the rotations of crops employed for clay soils and light soils. The Norfolk rotation is still used as a standard, and deviated from, rather by the choice of particular crops than by any great change in their general arrangement.

Beans, wheat, oats, cabbages, kale, rape, mangel-wurzel are all suitable for clay lands, and these crops ought to appear in every rotation for such soils. Even the bare fallow holds its place, and the best method of showing the difference between rotations for light and heavy soils is to make out two parallel systems, the one for light, and the other for heavy soils. These may be placed on either side of a typical rotation showing that both rotations have a general resemblance and similar principle running through them.

Rotation for light soils.	*Typical Rotation.*	Rotation for heavy soils.
Turnips	*Fallow*	Bare fallow
Barley	*Grain*	Wheat
Clover	*Fodder*	Clover
Wheat	*Grain*	Wheat or oats
Swedes	*Fallow*	Cabbage or mangel
Barley	*Grain*	Wheat
Clover	*Fodder*	Beans (consumed on the farm)
Oats	*Grain*	Wheat.

Framing Rotations.

In framing a working rotation of crops, it is necessary to put the fallow first, whether cropped or uncropped. A corn crop will always come next, but whether of wheat, oats, or barley, must depend upon circumstances.

If the land is bare fallowed or uncropped, it will naturally come into wheat, and indeed it would appear foolish to take any other crop, first because the class of land which is bare fallowed is always of a clayey nature and therefore suitable for wheat; and, secondly, because after bare fallowing there is no other corn crop likely to pay so well. After a cropped fallow it does not matter whether the land is put in oats or barley, but the latter is usually sown except upon strong land. Such land is cleared early of its roots, as in the case of mangel-wurzel. Early turnip or rape land is also often sown with wheat, but if December is reached before it is free for ploughing, it is then better sown with spring corn. Clover and grass seeds come in very suitably as the third crop of a rotation, but beans may be taken instead, or peas on lighty chalky soils. Wheat or oats follow as the fourth crop, and thus the rotation is formed either for light or for heavier soil. Sometimes the rotation is extended upon clay lands, as in the system known as the Carse of Gowrie course of cropping. In that district, which lies north of the Firth of Forth, a modification of the Norfolk rotation is pursued, and two more corn crops divided by a bean crop are added to complete the rotation. It runs as follows:—Fallow, wheat, barley, clover; oats, beans (dunged), wheat.

Abuse of Rotations.

A fixed rotation, to be observed rigidly without due allowance for soil, prices, and seasons, is not often enforced in these days.

There is however no objection to a few general rules being introduced into agreements between landlords and

tenants, such for example as that not more than two white straw crops shall be grown one after the other on the same field; that, for example, one quarter of the arable land should be regularly fallowed, *i.e.*, with root and fodder crops and not necessarily bare-fallowed; and that a *minimum* should be fixed as to the number of sheep (if a sheep farm) which must be wintered. Such general rules would be enough to prevent scourging cropping, and yet leave the cultivator free in his choice of crops.

CHAPTER III.

THE FALLOW.

Amount of Fallow in England.

According to the Government Agricultural Returns, there were in 1890 about 480,030 acres of bare fallow in England alone. This is a vast tract of land, exceeding in size the whole of Surrey or Bucks. It is also a larger area than is every year cropped with beans, vetches, or potatoes, so that we cannot look upon bare fallowing altogether as an old-fashioned practice.

Bare fallowing is most widely practised on the stiffest kinds of cultivated clays. At one time bare fallows were general on all soils; but since the introduction of the turnip towards the close of the seventeenth century, as well as of many other root and fodder crops, the area under bare fallow has been steadily diminished and devoted to the cultivation of turnips, mangel, cabbages, potatoes, and green crops.

Bare fallowing is now only practised on the strongest clay soils, and also upon lighter land when it is in a very foul or dirty condition from weeds.

Different Kinds of Fallow.

The term fallow does not always mean a bare or naked fallow. Fallows are, in fact, of several kinds, of which we may mention (1) the naked or bare fallow, in which the land lies free from crop from the harvest of one year until the autumn of the succeeding year,

when it is sown with wheat; (2) the **winter fallow**, when it lies from harvest until the next spring or early summer, and is then sown with turnips or some other root crop; (3) a **rag** or **half fallow**, when it is broken up out of vetches or clover in June or July, and given a thorough working before being sown with wheat in September; (4) a fallow entirely cropped, winter and summer, as in the Wiltshire rotation.

Explanation of the Term.

Fallow is generally understood to mean a time of restoration for the purpose of again bringing a field into the condition necessary for bearing saleable crops, especially of grain. As already explained, this may be done by the growth of root and fodder crops, but as the land must be made clean as well as rich, the root crop is most generally employed for this purpose. On light and easy working soils, fallows may be cropped during the whole period, by sowing winter rye or winter barley, vetches or trifolium, after harvest. These crops are eaten off with sheep in the spring, and the land is then sown with a root crop, which is again eaten upon the land by sheep, and corn follows. This system is, however, chiefly confined to light soils and to the southern counties of England.

Bare Fallowing.

Bare fallowing is a very expensive process, costing at least £5 per acre, exclusive of the cost of dung; and to this serious first cost is to be added that of the seed, sowing, after-cultivation, harvesting, and marketing of the wheat, which brings the total cost up to £8 or £9 per acre. It is certain that

at the present low price of wheat, there is very little, if any, room for profit. It must not, however, be forgotten that the benefit of a thorough cleaning and manuring of a field lasts for several years, and extends beyond the first crop, and, in fact, throughout the whole rotation. It is only upon this ground that the practice can be defended. If, for example, we make the wheat crop only pay one-half of the total expenses and divide the other half of the expenses among the remaining two or more crops until the next fallowing period arrives, then the bare fallowing may be profitable.

Theory of Bare Fallowing.

As the fact that land is improved by bare fallowing is very curious and not easy to be understood, it is necessary to explain it. To do so, it is important that the pupil should study the nature of soils by reading carefully the sections upon this subject given earlier in the series. The repeated ploughing and cultivating to which the fallow is subjected brings the entire mass of the soil under the influence of changes of temperature and the sweetening effects of the oxygen in the air. The mineral matter of the soil is made available as plant food, or, in other words, phosphoric acid, potash, lime, magnesia, iron, silica, and other matters required for supplying the ash constituents of plants are rendered soluble in the ground, and thus the soil is made rich *out of its own resources*. This is often expressed by the statement that the dormant parts—that is, the parts of the soil not yet soluble—are made active, that is soluble, and available for the wants of the plant. This is, however, by no means all.

There is in all soils a large amount of vegetable remains, consisting of the stubble, roots, leaves, remains of previous crops, and of dressings of dung. This organic matter (as it is also called) is not at once useful as plant food, but requires to undergo complete decay or slow combustion in the soil through the action of oxygen and other agencies besides, into which we cannot at present enter.* Tillage operations promote this complete decay and the giving out of carbonic acid gas and nitric acid within the soil, and these not only act upon the mineral matter in the soil by combining with it to form carbonates and nitrates, but also yield soluble plant food, especially in the form of nitrates.

By this slow process certain sour or acid substances in the soil are also decomposed by the oxygen of the air, and the consequence is a more wholesome or a sweeter condition of the soil. The iron in the soil is converted into the red oxide (familiar to us all as rust) instead of a black oxide, which is not a desirable compound, and this change again helps to make the soil wholesome for plants. This effect of the oxygen of the air upon iron in the soil is not unlike a similar change made in the blood of animals as it passes through the lungs. There the blood is made bright scarlet and healthy, although before it arrived at the lungs it had become almost black. This change is always going on in our own lungs and is the chief object of respiration or breathing.

The texture or mechanical state of the soil is also

* Allusion is here made to the action of minute living organisms in the soil in inducing nitrification.

improved by tillage—a fact which must not be overlooked, and should be kept separate in the mind of the pupil from the chemical changes above mentioned.

Now, what a farmer relies upon more than any of the above substantial and real benefits, is the cleaning of the land or the extirpation or destruction of weeds. This most important point should never be forgotten, as one of the chief reasons for giving land a bare fallowing. Besides all these advantages the custom of dunging and liming bare fallows becomes a main reason of the benefits which follow the process, and when all these points are duly taken into account, we cease to wonder that bare fallowing should produce good effects.

Essentials of a Fallow.

In fallowing, the land must be thoroughly cleaned, aërated, and fertilised.

Root Crops fulfil all these conditions except perhaps upon the very strongest soils. They require constant tillage throughout their entire growth. The ground must be deeply and thoroughly tilled before sowing, and well worked with horse and hand hoes during the growth of the roots. The land must be well manured. Finally, these crops are consumed by stock upon the field or at least upon the farm, almost always with additions of cake, corn, and hay, so that they give back, and more than give back, all the materials which they have collected from the soil, the subsoil, and the air.

It is only upon those stiff soils, where the treading of sheep or the passage of carts over the surface in taking off the crop undo the good effects of the root crop, that the

question arises as to whether a bare fallow is not better than root cultivation. This is one of the most difficult points for a clay land farmer to decide, and it involves the large question as to whether such soils can be cultivated as arable land to a profit. If bare fallows are unprofitable, and if root crops cannot be grown, it of course becomes a serious question whether such soils should be kept as plough land, or whether it would not be better to lay them down in grass.

Practice of Bare Fallowing.

When it is wished to bare fallow a piece of land it is better to wait until the winter or even till after the new year before beginning operations. The reason for this statement is rather practical than theoretical. There is no doubt that bare fallows might well be begun in the autumn, but it would appear wiser to devote the fine weather of September, October, and sometimes of November, to the working of land intended for potatoes, mangel, swedes, and turnips, in the following summer, and to leave the small area of land meant for summer fallowing for a time. Besides, the great object in working a fallow is the "roasting" of the weeds by means of the midsummer sun. A bare fallow should be rough and cloddy during the summer, as this is the right condition of the soil for the object in view. Now this is best obtained by breaking up the land from stubble in January or February. Hence, while the root land is rendered fine and moist, or what may be called mellow, by commencing to work it in the autumn, the bare fallow land is reserved for ploughing and working in the spring, thus producing

that rough and cloddy surface which serves best the purpose of the farmer. The autumn is a very busy time on all farms, and the greater amount of leisure of the early and late winter may be conveniently devoted to the bare fallow.

The Work of Bare Fallowing.

Every country child should know how a fallow ought to be managed. There are no doubt many ways of working a fallow, especially as regards the number of ploughings and dressings. In more prosperous times as many as nine ploughings used to be given, while five may be looked upon as usual. The first ploughing may be done in January in the same direction as the ridges which are always to be seen on clay land, forming round stetches of from three to four yards wide. This ploughing is given so as to split or throw down the ridges, *i.e.*, by turning the horses to the left at the ends of the work, and by beginning at the outsides of the ridges and ending the work in the middle. By this system of ploughing the old open furrow is filled and the new open furrow is left at the crown of the ridge, and hence the ridge is levelled or "cast." This first ploughing requires from three to four horses and is done from five to six inches in depth.

Supposing this first ploughing to have been done in January or February, the land is now left, and other operations occupy the teams. In April the surface will have become green with weeds and the land ought to be again ploughed in the same direction, reversing or turning back the furrow again, beginning at the open furrow and finishing as before in the centre of the previous ridge.

This buries the weeds, and the land is then again left until June, when it is cross-ploughed, *i.e.*, ploughed across the furrows so as to break up the land into large and rough clods.

It is after this that a series of draggings and heavy harrowings are commenced for the purpose of turning over the clods to the sun, so as to bake or "roast" them through, with the object of killing the weeds. Hand-picking of weeds is scarcely necessary in a good fallowing summer, as the heat of the sun suffices to destroy every green thing. In July the surface will have become reduced by the various tillage operations, and will be then ready to receive its fourth ploughing, or first gathering or right-hand ploughing, turning the horses to the right at the ends of the work and thus forming a ridge. Now is the time for applying dung or, in some cases, lime to the fallow. After dunging, the last ploughing or seed furrow is given, once more rounding up the ridges so as to restore them to the same rounded appearance as they had before the work was commenced.

The ground after summer fallowing should carry a fair sized clod upon its surface and abound in fine soil suitable for a seed bed. All operations should be finished before the end of August, and sowing should be accomplished as early in September as possible.

CHAPTER IV.

ROOT CROPS.

Root Crop Fallow.

The difference between working a bare fallow and a root crop fallow lies in the great importance of autumn cultivation in the case of the latter. As soon as harvest is over preparation for the next year's root crop should commence. Upon light and clean soils, especially in the South of England, it is very usual to get in a crop of rye, winter barley, or vetches, and to wait until these crops are fed off in the spring of the year before ploughing up again and working the land for roots. The system of catch cropping, which has been mentioned under the heading "The Wiltshire Rotation," is a favourite one in sheep districts, and is no doubt increasing in favour. This is due to the importance attached to the fact that much of the most valuable fertilising matter, the nitrates, wash through the soil during the winter, especially if the rainfall is heavy. It is found that a carpet of green, produced by an early sown fodder crop, checks, or entirely prevents, this loss through the action of the roots, which seize upon and hold the nitrates and store them up within the plants for the sheep in the spring. On all soils which are suitable for this method of cultivation it may be recommended.

This *catch cropping*, or *double cropping*, will naturally divide the attention of the pupil between the two crops, part of the operations properly belonging to the catch crop and part to the main crop. If the catch crop carries its own

share of the expenses of cleaning and preparing the ground, the cultivation of the root crop which follows is of course very simple indeed. If on the other hand the catch crop is only regarded as part of the cultivation necessary for the roots, the cost of growing the roots is not lessened, but rather increased.

It will be as well to leave the more difficult question of double or catch cropping at present, and to consider the more ordinary case of a root crop grown after winter fallowing.

Autumn Cultivation.

The phrase, Autumn Cultivation, has been much used for the last forty years. The pupil must not understand it to meau any cultivation done in the autumn, because it is not applied to autumn wheat sowing, or bean sowing, or cabbage planting. It is properly understood to mean the autumn cultivation of stubbles with a special view to the next year's root crop. On looking back to the section on "Rotation of Crops," it will be seeu that wheat and oat stubbles are generally to be found at the end of any system of cropping, and that such stubbles are iutended for roots the succeeding year.

If we want to understand the real value of autumn cultivation, we must imagine the case of strong or stiff clay land, and this because it does not matter so much whether the lighter soils are worked in the autumn or in the spring. We must further think of the stubbles as full of weeds or "trumpery," and on such stiff and foul land we have just the proper conditions for successful autumn cultivation. The case you are asked to imagine is a very common one indeed, and therefore the more useful and interesting.

The Steam Plough at work.

I wonder if my readers have ever seen a steam plough or steam cultivator! Sometimes on a day when harvest is about finished you will hear a strange noise along the road, and after a while two very formidable engines with great broad wheels come trundliug along, dragging after them a most extraordinary train. Therc is the great steam plough with eight turn furrows at each end; then follows thc grubber or cultivator, with seven tines or teeth hoisted np so as to ride clear of the ground; next follow the steam drags and water carts, and finally a house on wheels in which the workmen live. The boys aud girls rnsh out to see this strange thing, and if school is going ou they become very uneasy until the noise dies away in the distancc. These engincs are going to commencc autumn cultivation for some large farmer of the neighbourhood.

As soon as the engine men have got their appliances into thc field, they place the engines on opposite headlands, and with the help of a steel rope they proceed to work the cnltivator by letting down its teeth or tines into thc ground, and drawing it backwards and forwards between thc two engines. A man rides on the cultivator and guides it, or steers it with a wheel, as if he were steering a ship. It is a finc sight to sec the ground heaving up before the cultivator, and the man rocking abont in his seat as if he were tossed by the waves of the sea.

The Value of Steam Cultivation.

This is steam cultivation. It is very thorough and very rapid, as it will get over thirty acres in one day. This is a great help to the farmer, as it does as much in one day as all

his teams could do in double the time, and much more thoroughly. After the steam cultivator has done all the field the engines are placed on the other two headlands, and the cultivator is taken across at right angles to its previous path. By this means the first four or five inches of the soil are separated from the subsoil, and ready for working with horse instruments. Now there is a little fact connected with weeds which should be mentioned, namely, that they are never so weak, or attacked at such advantage, as immediately after harvest on a corn stubble. The overshadowing corn has weakened them, and the couch lies near the surface. If, then, the upper portion of the soil is well worked by a steam cultivator the weeds all come up in the moved portion of the soil.

How a Field is "Cleaned."

After the steam cultivator has finished no time should be lost in setting the horses to work to finish the good work. The steam drags may, however, be used to still further forward the cleaning operations, and, after steam dragging, horse harrowing, horse rolling, and chain harrowing may be relied upon. The upshot is that by means of the steam cultivator and other acts of tillage a goodly coat of couch and other weeds will be removed and burnt.

The land is next somewhat thinly ploughed, and again put through a course of dragging, rolling, harrowing, and chain harrowing, with the result of another less abundant coat of couch, which is likewise burnt, and the ashes spread over the surface. Thus a field is cleaned, and unless very stubborn these operations ought to suffice. Still in some cases certain spots require to be gone over even a third

time, although this will appear to some to be expensive tillage. After these cleaning operations the next thing to be done is to cart on a liberal supply of good farm-yard dung, but not in a rotten state. Dung ought to be long or fresh, or as it is sometimes called green, before it is put on in the autumn, because well rotten dung is apt to waste, but long dung stays in the land. About sixteen to twenty good loads per acre suffice, and it is then ploughed under with as deep a furrow as the teams can give it. Autumn cultivation, when thoroughly carried out, therefore, consists of three parts—1st, cleaning the stubbles; 2nd, applying dung; and 3rd, giving a deep ploughing, and leaving the field to the effects of frost until the turn of the year.

By this means the land becomes thoroughly pulverised by the frost, and well stocked with moisture, which it holds like a sponge.

The advantages of this system may be stated as follows :—

It exposes the stiff soil to the effects of frost, and this facilitates its pulverisation.

It exposes eggs and grubs of insects, and seeds of weeds, both to the hardships of winter and the ravages of birds.

It greatly facilitates, and forwards, spring cultivation.

It prevents the land from becoming too dry, as would probably be the case if all these cleaning operations were to be undertaken in spring instead of autumn.

Spring Cultivation.

As a principle, the more land that can be prepared in the autumn and the less that it is touched in the spring, the

better. If we are dealing with a clay soil, spring ploughing buries the fine surface produced by the winter's frost. If it is a light soil, too much cultivation in the spring dries up the moisture, and thus renders the growth of roots uncertain. The four important points to be attended to in the cultivation of all sorts of root crops are that the land should be **clean, fine, moist,** and **rich.** Let every agricultural pupil lay these characters well to heart. Let him remember that if one of them is absent his root crop cultivation will prove a failure. Let him try them over one by one and see if foul, coarse, dry, or poor land, is in the least likely to produce a root crop, and he will then see their vast importance.

It is not often, however, that we can do without some spring cultivation. Let farmers and bailiffs, therefore, beware of late spring ploughings. Most lands are better for a January or February, or even a March ploughing. There is still enough frosty weather in prospect to pulverise the furrow, and enough rainfall may be expected to prevent drought from getting in. If land is ploughed in April or May, caution is needed, and the roller should follow fast after the plough, so as to press down the clods and break them, as well as for the purpose of checking the escape of moisture. It is quite usual to remove yet another coat of couch, or weedy stuff, out of the land in the spring, and whatever the drags and harrows bring up to the surface should be raked or picked off, and by these means the field is made clean for the root crop.

The Plough a thorough Implement.

After all that has been said in favour of horse cultivators

or grubbers (I do not now speak of steam cultivators), there is no implement which gives such a complete cultivation as the plough. There is no escaping the plough if it is properly handled. The share cuts the whole under surface, and the furrow is completely turned over. It is especially fatal to all tap-rooted weeds, such as thistles, burdocks, coltsfoot, knapweed, bindweed, and red-shank. In spite of all that has been written of horse cultivators or grubbers, the plough still holds its own in the estimation of good farmers, and seems likely to do so. It must however be used with judgment.

Importance of judicious Tillage.

It is well to impress on pupils of agriculture that in all difficult soils good tillage is of even greater importance than manuring. To work land seasonably, that is when it is neither too wet nor too dry, and to work it well, are important points of farm management, and of good gardening also. The precise number of ploughings, harrowings, or rollings, which a field will require depends upon the season and the soil, and cannot be determined beforehand. The good farmer however possesses a thorough knowledge both as to what should be done, and how and when to do it. Perhaps no one thing more than this makes the difference between a successful and an unsuccessful farmer. The knowledge of it is only to be obtained by early training, natural taste for the pursuit, and long practice.

Of all the various kinds of cultivation carried out upon farms, none are so complicated or expensive as the cultivations for the various descriptions of root crops.

Expense of Root Cultivation.

The difficulty and expense of root cultivation contrasts strongly with the simplicity and ease of corn cultivation, and this being so, the root or fallow breadth (portion) of the arable land is usually taken as the measure of the labour required. If the farmer has enough horses to work his fallows or his root crops, he has enough of them to work his corn and other land. If he has a sufficient number of labourers to work his turnip crop, he is well supplied for the entire farm. The expense of root cultivation and the great risk of failure (for no crops are more liable to complete failure than these) have often been used as an argument for not growing them, or for greatly narrowing their acreage. The same argument applies in a still greater degree to bare fallowing, and the answer in both cases is the same. It is absolutely necessary that land should be put through a regular system of cleaning or cultivation once in four, five, or six years, as the case may be; and it is of course unfair to the first crop which follows such a thorough cleaning and working, if it is required not only to pay the whole of these expenses but to leave a profit as well. A more reasonable view is that the expenses of the preparation either for roots or bare fallow should be divided over the whole of the succeeding rotation.

The root crops when grown on suitable soils are a splendid preparation for a series of crops which are grown at much less expense, and it is not too much to say that upon all the lighter soils where sheep farming is followed on a large scale, business could not be carried on without them.

THE VARIOUS "ROOT" CROPS.

We have spoken of root crops generally, and it is now

time to show that there are very many kinds of crops which are spoken of under this head. As a teacher and an examiner in agriculture, the writer has often been vexed and disappointed to find the term "roots" used as if all that was necessary was to speak of them in this general manner. He has perhaps asked for a rotation for clay soils, and he is told that "roots" occupy the ground the first year. He next asks for a rotation for light soils, and again "roots" are given as the first crop. Now, although true so far as it goes, it is not sufficiently precise, because the sort of roots suitable for the one description of soil would be quite unfitted for the other. It is therefore necessary to state distinctly the sort of root, just as much as the sort of corn, or the sort of fodder crops which ought to be grown.

Fig. 2.—SILIQUA OF CABBAGE.

The Common Cabbage may be taken as the type of the tribe to which so many of our root and fodder crops belong. It is known by certain characteristics which belong to the entire class: the flower is cross-shaped or cruciform, and the fruit is a sort of pod, known as a *siliqua* (Fig. 2). If a pod of cabbage or turnip seed be taken (or of wall-flower or mustard—both of which belong to the same order), it will be found to open by two flaps or valves, both of which are united during their entire length, and on both sides, to a central frame, to which the seeds are fixed. A bean or pea pod will be found to open freely from the centre, and the

seeds will be seen attached on either side to the two valves which form the pod. The *Cruciferæ* constitute a large natural order, including a great number of plants all of which carry cross-shaped flowers, such as cabbages, turnips, radishes, mustard, cress, rape, wall-flowers, etc., and, like all orders, is divided again into families or genera.

The genus to which we shall now have to pay special

Fig. 3.—CLOSE-HEADED CABBAGE—SAVOY.

attention is that of the cabbages (*Brassicæ*). A more remarkable family of plants does not exist, for they possess the power of *variation* to a most extraordinary degree. Any one who knows even a little about cabbages must be acquainted with a large number of varieties. There are open-headed and close-headed kinds, and each of them may be further subdivided. The open-headed sorts are known as kales and borecoles; the close-headed as savoys (Fig. 3), imperials, ox-hearts, drumheads, etc., each of which is again known to have several sub-varieties. Another division supplies

cauliflowers and broccoli, in which the flowers form a compact cluster, or head. Brussels sprouts, sprouting broccoli, and branching majors, still further swell the list, and improved sorts are constantly finding their way into the catalogues of seedsmen. Kohl-rabi (Fig. 4) is another excellent example of the plastic or easily moulded nature of the cabbage family. This plant resembles an open-headed cabbage or kale, and has many varieties. Its peculiarity consists in a swelling of the stalk, until it weighs several pounds. Leaves spring out from this bulbous stem, just as they usually come from the stalk of a cabbage, and as they fall off they leave scars upon its surface. In flavour the bulb resembles that of cabbage-stalk, and it forms an excellent food for sheep and cattle, whether eaten in the ground where it grows, or stored and pulped.

Fig. 4.—KOHL-RABI.

Turnips form another group, which, although very different to ordinary cabbages, belong to the same genus, but to a different species. They include three principal varieties —swedes, yellow turnips, and white turnips, each of which contains a large number of kinds, very different from one another, both in appearance and character. They form the principal members of the root crop, and require to be separately noticed.

The common turnip appears to have been first cultivated in this country as a farm crop in the later years

of the seventeenth century. It was at that time sown broadcast and hoed out at a considerable cost—as we read of ten shilliugs per acre being paid for the work. A great improvement was effected in turnip cultivation in and after 1730 by the introduction, through Viscount Townshend, of the method employed in the Netherlands. This consisted in raisiug ridges or drills of about twenty-five inches wide, and splitting the same over dung spread in the bottoms of the ridges. The turnip seed was then sowed upon the top of the ridges. This system is now known as the Northumberland or Scotch system of growing turnips. We owe the more ordinary method of sowing turnips on a rolled surface by means of a drill to Jethro Tull, the inventor of the corn-drill and the father of horse-hoeing husbandry.

Yellow turnips are mentioned by Lisle, who wrote and observed between the years 1693 and 1722, and the same authority speaks of red or blue turnips, so that we may be sure that cultivated field varieties have been well-known for two hundred years.

Fig. 5.—SWEDE TURNIP.

Swedish turnips (Fig. 5) are of much more recent introduction, and are described as a novelty in the agricultural journals published iu the early years of the present century. They were brought from Sweden, and were noted for their extraordinary hardiness, as well as for their great value for feeding stock. It is curious to notice that even up to the present time the swede has not found its way generally into Northamptonshire—most of the farmers there preferring the white turnip.

GENERAL REMARKS ON TURNIPS AND SWEDES.

Comparing the three descriptions of turnips with each other, we find that white turnips are soft in flesh and also delicate in constitution, as, unless young, they readily rot when exposed to frost. They are more watery than yellow or Swedish turnips, and contain less sugar. They are inferior for feeding purposes, but are lighter of digestion, and more suitable for stock feeding from the end of September to the end of December. After the "turn of the year" swedes are preferred. Turnips may be grown on very poor and weak land, and there attain a heavy weight per acre, whereas yellow turnips and swedes must have better land. The principal varieties of white turnips are the Pomeranian White Globe, the Common White Globe, the Greystone, the Green Round, the Norfolk Red, the Lincolnshire Red Globe, the Improved Red Paragon, the White Tankard, the Purple-top Mammoth, and others. White turnips ought to be sown in May and June, and are most useful in November and December. They may also be sown in July and early August for late spring keep; and being well protected with leaves, and young, they continue to grow up to February, and are in that stage found to be capable of standing ordinary frosts.

Yellow turnips are in most respects intermediate in character between white and Swedish turnips. They are very probably half-breds, or hybrids, between the two. They are often used as an introduction to swedes, as it is desirable in feeding stock to avoid sudden changes in diet. Yellow turnips are well adapted for ewes and lambs, and are considered good for the production of milk. They

are yellow in flesh, and crisper, and sweeter, than white turnips, and contain less water. The principal varieties of yellow turnips are Dale's Hybrid, Fosterton Hybrid, Purple-top and Green-top Aberdeen Bullocks, Border Imperial, Tankard Yellow, and others.

Swedish turnips are easily recognised by their bluish-green leaves, which enable any person to distinguish them at a distance. The leaves are also smooth, and hold water in dew-drops upon their surface like cabbage leaves. They are cylindrical in shape, firm and crisp in the flesh, very hardy, contain less water, and are more nutritious than either the white or the yellow turnip. They are also better keepers, and may be relied upon for stock feeding up to May. Swedes should be sown in May and June, and require better land than the other sorts of turnips. The best known varieties of swedes are Skirving's Purple-top, Sutton's Crimson King, Webb's New Emperor, Bang-holm, Marshalls, Ashcrofts, Green-top, Mid-Lothian, Laings, and others.

These three classes of turnips differ from each other in composition as follows:—

	Dry matter per cent.	Sugar per cent.
White turnips	8	3·5 to 4·5
Yellow turnips	9	4·0 to 5·0
Swedish turnips	11	6·0 to 7·0

One of the greatest advantages of all turnips as food for stock is their digestibility. Although the amount of dry matter is not very great, it is all available, there being no indigestible woody fibre. Stock are also very fond of them. Although watery, they can be converted into a

most valuable food by adding straw chaff, hay, or a fair allowance of cake and meal.

The climate most suited to turnips is that of North Britain. There, not only the heaviest crops, but the best quality of turnips are grown, and they are esteemed as the cheapest stock food that can be produced.

TURNIPS AS FOOD FOR STOCK.

Turnips alone are not fitted for feeding sheep or cattle as they are too watery, and no breakfast for a flock of sheep could be imagined more uncomfortable than one of frozen turnips, on an exposed hill-side, after a keen frosty night.

Frozen turnips are below 32° Fahrenheit in temperature and yet they must be raised to 98° or 99° F. before they are as warm as the animal body. This is in itself a great waste of energy and food. The excess of water is also to be got rid of, which means further waste of power or force. It is upon these grounds that turnips have been condemned as food for stock, unless given in sparing quantities. It must, however, be plain that most fresh vegetable foods are of a watery character. All luscious and fresh fruits and vegetables contain from 70 to 80 per cent. of water, and the quantity of the same element in a beef-steak might astonish some of those people who object to turnips. Turnips are palatable, digestible, and rich in sugar, and as they are watery, they may be mixed with dry fodder, such as hay, straw, cake, and corn, so as to make a very excellent combination. A curious fact with regard to the extraordinary manner in which water

and solid matter are blended and incorporated together in turnips, was recently pointed out by Sir John Lawes, who showed that if a turnip be cut iuto cubes, scarcely any water escapes from the cut surfaces, and yet each of these cubes holds as large a proportion of water as an entirely liquid substance, such as milk.

Extent of Turnip Acreage.

Turnips constitute the chief division of the root crops. Of the 2,908,787 acres of roots grown over the United Kingdom in 1890, about 2,226,730 acres were turnips and swedes, and about 196,630 were cabbages and rape. The remainder of the area was composed of mangel aud carrots. These figures show how generally the root crops of this country are represented by turnips. The comparatively small area in cabbages and rape must not however be lost sight of, as these plants play a very important part in the work of stock feeding.

Comparative Value of Cabbages and Turnips.

Cabbages are more nutritious than turnips. They contaiu 11 to 12 per cent. of solid matter, and their feeding value as compared with turnips is placed by Dr. E. Wolff as 17 to 9, or nearly double as much. The value of cabbages is further increased by the fact that they are ready for use at a season of the year in which succulent herbage is comparatively scarce, *i.e.*, at the height of summer, when pastures are often burnt up with drought. The cabbage is so useful that it is of importance that the rising generation should have their atteution called to it. In the first piece, it is well suited for soils which are naturally too stiff for

swedes and turnips or even for mangel-wurzel. Secondly, it may be eaten by sheep on these soils at a period of the year when treading does no injury, and it then forms a capital preparation for wheat. In the third place, being raised in seed bed, the cleaning and cultivation of the ground for cabbage may be proceeded with while the young plants are growing in the bed ; and the planting of cabbages being done by hand, no pressure from horses and heavy implements is needed. These are all very important points in favour of cabbage cultivation. The plants root easily, and after being horse-hoed and hand-hoed in the spring, and dressed with about 2 cwt. per acre of nitrate of soda, they grow with amazing rapidity, and cover the ground with a compact mass of exceedingly rich food. Not only so, but the cabbage is a marketable crop, and may be sold at a high figure if they are not needed for stock feeding.

Planting Cabbages.

Cabbage seed should be sown in the first week in August upon a well prepared and dunged seed bed in a sheltered situation. The seed is best drilled about 13 inches apart between the rows, and this may be done by taking the drill with the coulters set 26 inches apart, twice over the ground, and dividing the space between the rows made in the first operation. A little superphosphate* assists the young plants materially. If the ground is mellow, the seedlings quickly appear, and soon pass into

* One of the most ordinary manures employed in agriculture. It is produced by treating bones, or any substance rich in phosphoric acid, with sulphuric acid, which produces an easily-dissolved substance called superphosphate.

the second or rough leaf. They are allowed to grow together in the seed-bed until the field where they are eventually to grow is ready for them. From two to four pounds of cabbage-seed will be needed for half an acre of seed-bed. For every acre of field which is to be planted, from one-half to one pound of seed will be required in the seed-bed.*

The Field intended for cabbages should meantime be got ready, and as it may be expected to be foul after a wheat crop, the cleaning operations already recommended under the heading of "Autumn Cultivation" will probably be employed in the first place. The pupil would therefore do well to read the directions for cleaning foul land again in this connection. After an application of good farm-yard manure, the land should be ploughed and pressed with a wheel presser, which not only produces a firm bottom for the cabbage to root in, but gives a line for the cabbage-planters to follow.

The plants will be set in every other press line, or eighteen inches apart, or in the case of drum-heads in every third press mark, or twenty-seven inches apart. The

* The following extract from my own farm diary, October, 1889, may be useful. "The cabbage seed bed in this (No. 11) field has been admired by many people. To-day we measured some small portions, and found, repeatedly, that there were from 500 to 600 good plants on about twelve square yards, or on $\frac{1}{403}$ acre. That is, from 5,000 to 6,000 plants on $\frac{1}{40}$ acre. According to this result, enough cabbage plants would be growing on from $\frac{1}{12}$ to $\frac{1}{10}$ acre of seed-bed to plant out one acre in the field. Or, stating the quantities more precisely:—

From 15,000 to 18,000 cabbage plants would be found on . . $\frac{1}{13}$th acre of seed bed.

From 20,000 to 24,000 cabbage plants would be found on . . $\frac{1}{10}$th acre of seed bed."

plants are drawn iu damp weather from the bed, and dibbled in with a commou hand-dibble, such as is used in setting potatoes. The soil should be further consolidated about the roots by pressure of the heel of the planter, a plan which is sufficieutly well-known to be spoken of as "heeling."

The long ends of the tap roots should be pulled off before planting, as the progress of the plant is stopped if the tap root should be doubled up. About 20,000 plants are required for one acre when placed eighteen inches between the rows, and eighteen inches between the plants in the rows. The actual number, if we were to work out the sum, would be 19,360. Planting from the seed-bed will commence in October, and may be continued throughout the winter whenever the weather is open, and such progressive planting has the advantage of producing a suecession of cabbages for use, as those earliest planted are soonest ready. Towards the close of the planting-out season, *i.e.*, in March, the whole of the area under cabbage should be gone carefully over, and all gaps should be filled up with plants.

Spring-sown Cabbages.—A seed-bed for cabbages may be made in March for furnishing plants for setting out in May or June aud for consumption in October. For ordinary agricultural purposes the autumn seed-bed and winter plauting out is to be preferred, as on stiff land thc rooting of thc plants is easier and safer in the damper autumn, than iu May aud June.

Thousand-headed Kale.

This most useful addition to our fodder crops was in-

troduced to general notice by the late Robert Russell, of Horton, near Dartford, in a paper read before the Farmers' Club (London) in 1876.

In general appearance it resembles rape, but the foliage is lighter in colour, and the habit of growth bolder and more branching. The peculiarity which gives to it its name consists in a development of buds at the axils or angles where each leaf springs from the mainstem. By the branching growth of these buds a mass of fodder is produced which far exceeds that from rape or any other fodder crop (Fig. 6).

Fig. 6.—KALE.

The cultivation of kale is so much like that of cabbages, that half, or a portion of the cabbage seed bed may be sown with kale, and part of the field prepared for cabbage may be planted with kale, both plants being treated alike. Kale is however not only a stronger grower

than cabbage, but it roots more quickly and strongly in the ground.

When once kale takes possession of a field it will last for several seasons. It is fed off with sheep in May or early June, and if the bark of the stem is not gnawed by too close feeding—a thing which is easily prevented by not allowing the sheep to be too long without a fresh piece—it quickly throws up fresh branches or heads, and in two or three months is as thick on the ground as ever. It may then be fed in the early autumn, and a fresh crop will be available for spring feed. Although kale may be sown in the field in April, for summer use, and in August, for spring use, without the intervention of the seed-bed, the best results are obtained by transplanting out of a seed-bed. One of the main objects in endeavouring to teach agriculture is to impress the importance of processes and products, which, although well known in some districts have scarcely as yet made their way into others. The cabbage and the kale are instances of this slowness to appreciate valuable crops. There is no doubt that both cabbages and kale only require to be tried, especially by clay land farmers, in order to secure their general adoption.

Kohl-rabi.

This plant has already been described (page 44). Although it possesses the great advantages of hardihood, freedom from insect attacks and disease, and is well adapted for withstanding drought, and does well on clay land, its progress is slow, and the area under it is still very small. It is most esteemed upon the fen lands of the

eastern counties, in South Lincolnshire, Cambridgeshire, and the adjoining counties, as black peaty soils are not suitable for swedes and mangel, and seem to be especially adapted for producing heavy crops of kohl-rabi and of rape.

Rape.

This is one of the most commonly cultivated forms of the genus *Brassica*. It so closely resembles Swedish turnips in its general habit of growth as to be considered as belonging to the same species. It differs chiefly from Swedes in its root, which is fangy, divided, and tough. The difficulty of getting rid of rape roots is sometimes objectionable. Rape is grown entirely for the sake of its leaves, which are very abundant and of high feeding value. The growth of the plant is exceedingly rapid; and when it has been eaten off the stumps will sprout afresh and produce an abundant second crop. It grows best on peaty and clayey lands and rich loams, but may also be cultivated on any fairly productive soil. Rape may be viewed as a kale or borecole, as it greatly resembles these plants. It is, however, much better known to farmers, and is widely cultivated, under the name of Coleseed in Lincolnshire. The cultivation is precisely the same as for turnips, and it is sown in April and May for consumption in July and August. It is also sown in July and August for standing the winter and for furnishing excellent early spring food in April.

MANGEL-WURZEL (Fig. 7).

(*Beta Maritima*).

Mangel Acreage.

The area of land in the United Kingdom under mangel

in 1890 was about 370,650 acres, of which 318,060 acres were grown in England, 43,990 acres in Ireland, and 6,970 acres in Wales, leaving only 1,630 acres for Scotland. These figures show that mangel is rather suited for the milder climate of South Britain and Ireland than for Scotland. As already mentioned, the finest turnip crops are grown in North Britain, and there is no doubt that the suitability of the turnip for the north, and the delicacy of the mangel-wurzel, and its consequent liability to injury from frost, are the reasons why it is not widely grown in the north of England or in Scotland. As a food for stock it is superior to turnips, as it contains more dry matter, and a larger proportion of sugar than they do. Thus, while swedes, the richest of the turnips, contain 11 per cent. of dry matter, of which 55 to 64 per cent. is sugar; mangels contain 12 to 12·5 per cent. of dry matter, of which 60 to 68 per cent. is sugar. Add to this superior composition the fact that mangel-wurzel is capable of producing much heavier yields per acre than turnips, and the case in favour of mangel appears to be perfectly clear.

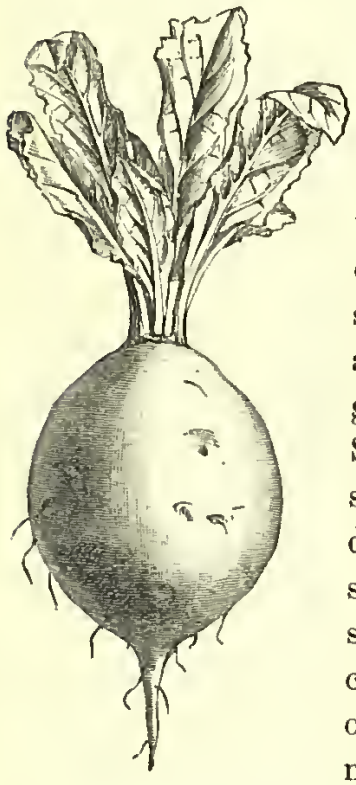


Fig. 7.—MANGEL-WURZEL.

The wider cultivation of mangel is, however, limited by two considerations: first, it will not grow on nearly so many descriptions of soils as turnips. Secondly, it will not stand the winter, and therefore must be hauled

off the land and stored in well-thatched heaps. When so stored it will keep for many months, and is often reserved until June and July, and fed with cut green food. Mangel growing should be confined to such level lands as abound by the sides of rivers, and to deep and rich soils, wherever found. It is not grown on the higher slopes of wolds and downs, nor on tracts of poor thin soil, on all of which swedes or turnips may be easily produced. Neither is mangel-wurzel so well adapted for sheep feeding as turnips, for sheep farming usually prevails on uplands, and on chalky soils which chiefly owe their condition to sheep folding. That mangel in moderation* is an excellent food for sheep as well as for cattle no one can doubt, but it is best bestowed upon sheep in the warmer seasons of the year, and it then makes a very excellent addition to vetches or other fodder crops.

Mangel-wurzel is rightly considered to be exhausting to the land, as must be any bulky crop which is removed off a field. In this respect it compares with turnips or swedes removed off the land. It is also looked upon as an expensive crop to cultivate, owing to the fact that, being removed off the land, and being a very bulky grower, it can only be produced with plenty of farmyard and artificial manures. It also entails expensive haulage. Such considerations are sufficient to account for the comparatively small area under mangel.

Mangel-wurzel is closely allied to both garden beet and sugar beet, and is supposed to have been first produced by

* Mangel is found in many districts to be unsuitable for wether or male sheep, although it may be given to female sheep without inconvenience. In small quantities, and when mixed with other food, as above recommended, it may be used for all kinds, and both sexes, of sheep.

a cross between the red and white varieties of the garden beet-root. It belongs to the natural order **Chenopodiaceæ** or goose-foot, to which spinach also belongs. The habits and requirements of mangel-wurzel are very different from those of turnips, and the pupil should particularly note each of them, as there is too great a disposition on the part of farmers to regard all root crops as being much alike, requiring the same treatment, and the same fertilisers. The botanical difference ought to be sufficient to prepare us for differences in habit and growth. I have therefore placed the main differences between turnips and mangel in parallel columns, so that the important points in which they differ from each other may be the more readily noted.

Mangel-Wurzel	Turnips, including Swedes.
1. Thrives best in a hot and rather dry summer.	1. Thrive best in a cool and moist summer.
2. Prefers a strongish loam.	2. Prefer a light soil.
3. Thrives only on good land.	3. Will thrive upon poor land, although swedes require better land than turnips.
4. Is greatly benefited by the use of nitrogenous manures.	4. Are but little affected by the use of nitrogenous manures.
5. Is not much influenced by phosphatic manures.	5. Are greatly influenced by phosphatic manures.
6. Is benefited by applications of common salt.	6. Are neutral as to applications of salt.

There are, of course, many other points of difference, but the above are mentioned chiefly to show that in selecting soils and situations, as well as in the treatment of the crop, mangel-wurzel must not be considered as one with turnips and swede.

The principal varieties of mangel are the Long Red, the Red Globe, the Long Yellow, the Orange Globe, and the Intermediate.

CARROTS AND PARSNIPS.

Carrots.

Carrots (*Daucus carota*, Fig. 8) are not widely cultivated, only 19,655 acres having been grown in the United Kingdom in 1888. They are frequently grown on small patches upon farms as a favourite food for nag horses.

The carrot belongs to another natural order, the Umbel-

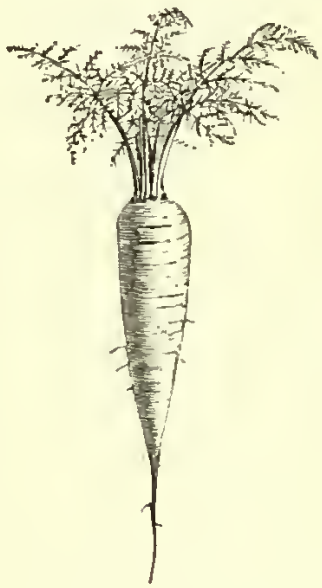


Fig. 8.—CARROT.

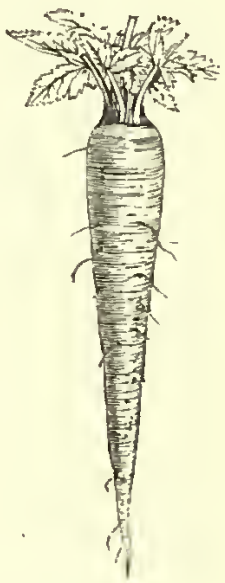


Fig. 9.—PARSNIP.

liferæ, which abounds in plants of pungent flavour. The wild carrot is a common weed in arable land, and it is the parent form of the cultivated carrot.

Carrots are best cultivated upon deep sandy soils or upon deep or loamy clays free from stones. The best

varieties are the White Belgian, the Red Altringham, and the Large Red Cattle Carrot. The cultivation includes the thorough and deep working of the ground in the spring. The carrot seed is mixed with sand in order to prevent the seeds from sticking together, and a few oats or a little barley are introduced, for the purpose of showing the direction and situation of the rows when the seeds first germinate.

Sowing.

The seed is sown in March or April with the drill, taking care that it is not deposited more than half an inch below the surface, and that it is then very lightly harrowed, and the surface rolled down. Six to eight pounds of seed are sufficient for one acre, and the rows are drilled about twelve to eighteen inches apart.

Harvesting.

The most troublesome and expensive part of carrot cultivation is the harvesting. Each carrot requires to be lifted separately, and the best instrument is a two-pronged fork, twelve to fourteen inches long, and set about three inches apart. A tread or shoulder is provided for the foot of the digger. The work costs from twelve to thirty shillings per acre, according to the crop. If the weather is open and fine, the roots should be allowed to dry before storing, and they are then packed in clamps about three feet wide, and two feet high. The clamp is built by arranging the carrots with the crowns outwards and their tails towards the centre of the heap. By this plan the clamp presents a neat appearance, and it is then covered with straw and earth. Ventilation should be ensured by

placing draining tiles to act as chimneys, for the escape of warm and moist air, at intervals of about two yards along the top of the clamp.

Parsnips.

Parsnips (*Pastinaca sativa,* Fig. 9) are cultivated in the field to a small extent. They also belong to the **Umbelliferæ,** and the parent form is found growing wild as a weed in fields and hedgerows. It is extensively grown in the Channel Islands, and much esteemed as a food for pigs and cows. Carrots and parsnips are both highly nutritious, and are, weight for weight, almost double the value of turnips for feeding purposes.

CHAPTER V.

CULTIVATION OF ROOT CROPS.

Having described the different root crops, we are now in a position to see clearly that, although all may be spoken of as "the root crop," they have not only different uses but are adapted to many variations of soil, situation, and climate.

For the heaviest classes of clay soils, which were formerly bare fallowed every three, or from that to six years, we now have an excellent choice between bare fallowing and cabbages, kale, rape, or kohl-rabi. It is true that skill and judgment are required in the tillage of such land, but, by taking advantage of autumn cultivation, magnificent cabbages and kale may be grown. Also by retaining the fine surface produced during the winter, rape and kohl-rabi may be drilled in the spring, with fair prospect of success. If the season is not favourable to these cultivations we can at least fall back upon the time-honoured practice of bare fallowing.*

For clay soils of a less stubborn character the same crops are suitable, and will be grown with less difficulty; and mangel-wurzel also becomes a possibility, while a few acres of white turnips may be attempted upon a finely worked seed bed, for consumption in September.

On strong loams almost all the root crops may be attempted with a preponderance of mangel-wurzel, swedes, and cabbage.

* Such exceptionally stiff soils are, no doubt, best put down to permanent pasture.

On **loams of light character** a great variety of root crops suitable for sheep may be cultivated with ease and profit.

On the **lightest soils** white turnips should be the staple.

On **peaty soils** rape and kohl-rabi will be found most suitable.

On **chalky limestone** or **calcareous** soils swede turnips grow very well if early sown, as also do rape and white turnips. These are favourite foods for sheep, and here we find the choicest situations for sheep farming.

All soils, in a sense, **will grow all crops,** but in planning rotations—and especially in recommending them to others—care should be taken to select those crops which experience has proved to be best adapted for special soils and climates. Practically, we are not left to our own unassisted judgment in this matter, for the opinion of the farmers of a district has generally already been given in favour of certain crops, and new ones should be introduced with great care, and by growing small quantities at first.

How to prepare the Land.

The preparation of the land in the case of root crops has been seen to consist where possible in thorough cleaning, dunging and ploughing before winter. It is not however possible to do the whole of that work before the weather breaks, and the winter's rains and frosts set in. In our uncertain climate we have to resume tillage operations when we can, and hence a good deal must necessarily be left until March winds again dry the surface. The heavier portions should by all means be brought into a

forward state in the dry months of autumn, and the lighter soils may be left until the opportunity presents itself.

Raftering and Ridging (Fig. 10).

There is a method of working light soils which many good farmers practise. It consists in "raftering" the stubbles in the winter, and leaving them in this condition until the spring. The method is as follows. The plough cuts a shallow and level furrow, throwing it face downwards upon the stubble, so that the firm land and the turned furrow lie face to face, sandwichwise. This is repeated over the entire surface of the field, which then presents a ribbed appearance, as in the accompanying figure.

The process is also known as half-ploughing which indeed properly describes it.

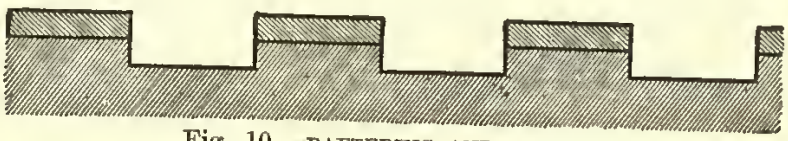


Fig. 10.– RAFTERING AND RIDGING.

The effect of raftering is that the weeds are smothered and rot during the period of low vitality which prevails in winter. The next operations take place in dry weather, in the spring, and consist in heavy harrowing or dragging across the raftered surface, and a crop of weed roots is the result, as the drags not only tear the moved portion, but also the fast portion which underlies the rafters. After the weeds have been gathered, burnt, and disposed of, the land is ploughed, and again subjected to the minor cultivation of dragging and harrowing, and then a fresh lot of couch and weeds is obtained. A third ploughing and

working follows, and by this time the land ought to be fit for drilling.

Ridging up clay land before winter is a system which has many advocates. The plan was described by the late Mr. James Howard somewhat as follows. The field having been well worked by the steam cultivator, is ridged up by means of a double mould-board plough in drills twenty-five to thirty inches apart. The dung is carted on and the ridges are split over it. The land is then allowed to lie and "make" under the influence of frost until the spring. In April the ridges are harrowed lengthways with a curved harrow shaped for the purpose, and formed up again with the double mould-board plough; the effect being a wonderfully fine tilth upon which mangel seed may be drilled.

Sowing on the Ridge and on the Flat.—The two principal systems of turnip sowing have been already indicated (page 45). Sowing on the ridge is the usual method adopted in Scotland and Northumberland, while the system of drilling upon a finely worked and rolled surface is more ordinary in the south. Unquestionably the finest crops of turnips are grown on the ridge, but this is probably owing to the more favourable climate of the north for the turnip. The larger surface that the ridges offer for evaporation is regarded as a drawback in drier climates and on drier soils, and on these the system of sowing with a drill upon the flat is employed. (*See* page 97.)

Time of Sowing.

The sowing of the root crops is summer work. The earliest sowings are those of **mangel-wurzel**, which are

made as early as Mareh, although more eommonly in April, and extend into early May. Probably the best period for sowing mangel is the third week in April. The first sowings of rape are made late iu April and in May for feeding off the land in July and August. Later sowings of rape may be made in July for spring keep.

Kohl-rabi is sowu in April in the opeu field, but if sown in seed bed the sowings are made—Mareh 1st, April 1st, and May 1st, for transplanting out in May, June, and July. White Turnips for early feed may be sown in May, for main erops in Juue and early July, and for late spring keep in late July, August, and early September. Swedes may be sowñ in the latter end of May and throughout June, and, in some eases sneeessfully, early in July.

The dates first given are those employed in the South of England, but as we travel northward the season tends to beeome earlier. Thus iu Northumberland swedes are sown on and about May 13th, and white turnips for main erop should be in by Juue 20th.

Quantity of Seed.

The quantity of seed required to plant an aere of swedes or turnips is very small. Mr. Slatter, of Stratton, near Cireneester, who died at a great age a few years ago, told the author that he found one pound of tnrnip seed per aere suffieient.

This no doubt it is, if the seed comes np freely and eneounters no inseet enemies. Two pounds are also sometimes used, but a more ordinary and safer quantity is three pounds per aere. As tnrnip seed does not eost more than eightpēnee per pound, the expense is slight, and it is not wise to

risk the crop for an extra eightpence per acre. On the other hand, if turnips braid too thickly they are difficult to set or single. When it is remembered that at least nine out of ten of the young plants are to be cut out by the hoe in the process of singling, the amount of seed actually required to provide plants for an acre is probably not more than from three to five ounces.

Distance apart between the Rows.

In Jethro Tull's* book on horse-hoeing he instructs his readers to make experiments for themselves to test the distance to which roots will extend from the centre of a plant. He considers that a turnip will draw nourishment from soil "three or four feet or more" from its tap root. It was Tull's custom to drill his turnips three feet apart, and even much wider. Quoting from Cobbett's edition (1822) we read as follows: "The six feet ridges, whereon turnips are drilled in single rows may be left higher than for double rowed (three feet) crops . . . Between these rows of turnips I have planted wheat . . . and towards the spring pulled off my turnips, and carried them off for cattle." Jethro Tull was an extraordinary man, and was far in advance of his time, drilling turnips at wide intervals when his neighbours were still broadcasting them.

We cannot however follow his advice as to growing turnips at such extremely wide distances. First, we have learnt that a big turnip weighing twelve pounds is not

* Jethro Tull was a writer on agriculture who flourished upwards of one hundred years since. He invented the drill and the horse-hoe, and his system of drilling both corn and root crops has been generally adopted.

nearly so nutritious as fair-sized turnips weighing four pounds each. The late Dr. Voelcker found that big swedes and mangel often contain ninety-two and ninety-three per cent. of water, whereas good moderate-sized swedes and mangel only contain eighty-eight per cent. "In such watery mangels the proportion of dry or feeding substance in one hundred parts weighs only seven pounds, whilst good roots contain twelve pounds of dry food in every hundred pounds."

The injurious effect of planting at too wide an interval in the case of sugar beet has been well shown by M. Ladureau, quoted by Dr. Voelcker :—

Distance apart of rows. Inches.	Yield per acre. Tons. cwt. qrs.	Specific gravity given.	Percentage of Sugar.
10	28 0 0	1055·5	11·62
12	27 12 3	1055·0	11·21
14	27 15 3	1050·0	10·48
16	25 1 3	1051·0	10·61
20	25 5 2	1046·0	8·97

These figures not only show that the quality of the sugar beet was lowered by wide drilling, but there did not appear to be any increase in the weight per acre of the crop. Although it might be objected that these results are not applicable to turnips, yet we may consider that they show that it is wiser to grow smaller roots and to keep up the weight per acre by growing more of them—that is by leaving less space between them.

Next as to ordinary practice. For swedes and mangels thirty inches is about the greatest width which is adopted on good land, for early sowings, or when a maximum yield may be expected. A more usual distance, used as a standard

in the North of England and Scotland, is twenty-seven inches.

In the midlands and southern counties large areas of swedes are drilled at eighteen to twenty-four inches apart, but wider intervals are still employed for mangel-wurzel.

In the eastern counties, where the climate is drier than either in the north or west, fourteen and sixteen inches is a common width for turnips and swedes. Later sown crops will be sown nearer together than earlier ones.

Distance between Plants in the Rows.

The same principle regulates the distance between the plants in the rows. Mangel-wurzel requires more room than swedes, and swedes than white turnips:

Mangels may be left 15 inches apart in the row.
Swedes „ „ „ 13 „ „ „
White turnips „ „ 11 „ „ „

CHAPTER VI.

MANURING THE ROOT CROPS.

Necessity for plenty of Manure.—It is impossible to grow either turnips, swedes, mangel, or any root crop, unless they are well manured. The same is true of those allied crops—rape, kale, and cabbage. All of them must be liberally treated.

This is not so much the case with cereal crops, which, as will be afterwards shown, continue to yield fair returns for a long series of years without manure of any kind.

The root crops are greedy and needy. If the pupil looks back to page 11 he will see that the requirements of the root crops are much greater than those of wheat. Not only so, but the root crops occupy the ground a much shorter time than the cereal. September sown wheat is about eleven months on the ground, and collects its food whenever the temperature of the air and soil allow it to do so. Mangel-wurzel or swedes only occupy the ground from May to October, or in other cases from June to winter, and their period of active growth only extends over about six months. The root crop is like a great growing boy, always hungry : the cereals are smaller in bulk, and take their food more leisurely.

Dr. Gilbert has laid stress upon the exhausting character of the root crop. No class of crops will so soon impoverish a soil and reduce its power of yielding. This is shown by the following case, in which white turnips were grown for three consecutive years upon the same land

without manure, the crop and its leaves being in each case removed.

	Tons	Cwts.
1843	4	$3\frac{3}{4}$
1844	2	$4\frac{1}{2}$
1845	0	$13\frac{3}{4}$

Good Root Crops a Sign of high Condition.

No better indication of the condition of land can be noticed than the state of the root crops. Heavy crops of mangel, swedes, and turnips are signs that the land is full of condition, or, as north country farmers say, "full of management," and wretched crops of roots are a sign of poverty, either natural or induced.

The net result is that the root crops are collectors of fertilising matter or plant food, and the great point is that they should be consumed upon the land or at the homestead, so that what they have collected shall be given back to the land. Further, let it be understood that this matter is returned to the soil in a suitable condition for immediate use; it is available soluble plant food, and is at once laid hold of by the soil, and held by it for the use of future crops.

Farmyard Manure for Turnips and Swedes.

No artificial manures can replace farmyard dung as a dressing for turnips and swedes. It is true that a crop of swedes or turnips can be grown with superphosphate alone, upon land in ordinary farming condition. Any attempt, however, to grow successive crops of turnips upon the same land and cart off the produce, except with repeated dressings of dung, would end in complete failure. We may venture

on another statement, namely that when turnips and swedes are well dressed with farmyard manure no artificial fertilisers will greatly increase the crop; the plants apparently not needing any other assistance. If land is in high condition from previous good farming, which of course entails previous dressings of farmyard manure, no artificial dressings will tell at all, and, strange to say, they sometimes in these circumstances produce *minus* results.

Farmyard manure is a general fertiliser, and contains nitrogen in organic combination, as well as mineral matter. Nitrate of soda and sulphate of ammonia exert small and uncertain effects upon swedes and turnips, and hence no combination of phosphates and artificial nitrates can rival farmyard manure.

This was amply proved at Rothamsted through a period of fifteen years' growth of swedes upon the same land. In this series the best results were obtained from fourteen tons per acre of farmyard manure applied annually, while the results obtained from dressings of superphosphate, aided with 400 lbs. of sulphate of ammonia, or of 550 lbs. of nitrate of soda (both particularly heavy dressings) yielded very inferior crops to those produced from the dung.

The power of dung to supply all that is needed for the growth of a crop of swedes is also shown by results obtained in an extensive series of experiments carried out near Cirencester. Mr. Hawkins obtained the following results from the application of various dressings upon land in good condition from previous dungings and general good management.

GENERAL RESULTS OF EXPERIMENTS TRIED ON MR. HAWKINS' LAND.

	Tons	cwts.	lbs.
2 plots unmanured, but in high condition from previous management	12	18	64

			Tons	cwts.	lbs.
2 plots dressed with	3 cwt. superphosphate,	per acre ...	12	7	96
2 „ „ „	3 „ superphosphate, 1 „ nitrate of soda,	per acre ...	10	15	70
2 „ „ „	3 „ superphosphate, 2 „ dissolved guano,	drilled together, per acre	10	17	76
2 „ „ „	3 „ superphosphate, 2 „ dissolved guano,	sown separately, per acre	12	17	16
1 „ „ „	3 „ superphosphate, 1 „ nitrate of soda, ½ „ organic matter, ½ „ potash salts,	per acre ...	9	10	0
2 „ „ „	3 „	patent bone phosphate, per acre	10	18	24

So also in the case of Mr. Price's experiments, when dung was applied, the superphosphate ceased to tell, and in fact gave a *minus* result. In this case a coat of dung increased the crop from 9 tons to 14½, or by 5½ tons; and further additions of superphosphate, of guano, and even of superphosphate and nitrate of soda combined, were not able to further raise the yield perceptibly. The results obtained by Mr. Price were as follows:—

	Yield per acre. Tons	cwts.	lbs.		Average increase or decrease over farmyard manure plots. Tons	cwts.	lbs.
2 unmanured plots	9	8	44	... ...	— 5	8	90
	8	13	4				
2 Farmyard manure	14	2	16	... ...	standard		
	14	16	88				
2 Farmyard manure, and 3 cwt. superphosphates	15	3	84	... ...	— 0	18	25
	11	18	84				
2 Farmyard manure, and 3 cwt. dissolved guano	13	16	108	... ...	— 1	9	13
	12	3	84				
2 Farmyard manure, 3 cwt. Peruvian guano, 3 cwt. superphosphates	15	10	40	... ...	+ 0	12	97
	14	14	36				
2 Farmyard manure, 3 cwt. superphosphates, ½ „ nitrate of soda, ½ „ potash salts, ½ „ organic matter,	14	0	0	... ...	+ 0	12	55
	16	3	104				
2 Farmyard manure, 3 cwt. Peruvian guano	11	10	40	... ...	— 2	12	7
	12	4	52				

The above figures are very striking, as showing that the farmyard manure alone was all that was necessary.

Artificial Manures for Turnips and Swedes.

The substance, of all others, which turnips and swedes require is phosphoric acid. A seventeen-ton crop of turnips contains in its roots and leaves thirty-three pounds of phosphoric acid, and a twenty-ton crop of swedes about the same, while thirty bushels of wheat and its straw only require twenty-two and a half pounds. The rapidity of growth of the root crop necessitates a ready supply of all it requires, and hence the importance of a high condition of soil. Under certain circumstances, the effect of superphosphate upon the turnip crop is most extraordinary. For example, when turnips or swedes are grown in ordinary rotation of crops, the soil is in receipt of farmyard manure or sheep's droppings every other year, and its constituents are called upon in a sort of rotation corresponding to the crops. In such circumstances, superphosphate will, especially if the soil be in comparatively low condition, often produce very marked results indeed. The effect of the superphosphate may be thus explained. The soil is sufficiently stocked with nitrates,* sulphates, potash, lime, chlorine, etc. The weakest link in the chain is phosphoric acid, and this being supplied, the plant helps itself to the other substances at hand, and vigorous growth is the result.

On the other hand, if from previous or immediate dressings of farm-yard manure, or from natural richness, there is an abundance of phosphoric acid (as well as of the

* The turnip is, like all root crops, grown in soils which have been thoroughly worked, and are also growing in the hottest months of the year, and in these conditions "nitrification" is known to be most active. Although the soil may not be particularly rich in nitrogen, the conditions are such that the turnip finds all it needs.

other substances required) in the soil, further additions of superphosphate fall flat, and produce no effect, as in the cases above given. The same reasoning may be applied to any other substance necessary for the growth of the plant. If potash is deficient in a soil (which, however, is rarely the case), potash salts will tell in a distinct manner on the crop, and if lime is wanting in the soil, a dressing of lime will act as powerfully as might potash or superphosphate in other cases. It is therefore clear that before artificial manures can be applied with success, the farmer must know the nature, the condition, and the composition of the soil.

In the great majority of cases, phosphoric acid* is the weak element, and hence it is that in using superphosphate the farmer hits upon the very thing that is needed. So rarely, indeed, is any other substance wanting, that

* The extraordinary effect of superphosphate upon these crops when land is poor, or when it is not dunged, is shown in the following results, which were obtained at Dean Farm, Fairford, Gloucestershire, no farmyard manure being used.

			Tons	cwts.	lbs.
2 plots, unmanured			2	5	50
2 „ manured with 3 cwt. superphosphate, per acre ...			12	16	48
2 „ „ „ { 3 „ superphosphate, / 1 „ nitrate of soda, } per acre ...			13	2	86
2 „ „ „ { 3 „ superphosphate, / 2 „ dissolved guano, } drilled together } per acre			15	8	34
2 „ „ „ { 3 „ superphosphate, / 2 „ dissolved guano, } sown separately } per acre			14	19	76
2 „ „ „ { 3 „ superphosphate, / 1 „ nitrate of soda, / ½ „ organic matter, / ½ „ potash salts, } per acre ...			14	16	38
2 „ „ „ 3 „ patent bone phosphate, per acre			9	1	3

dressings of potash salts, of nitrate of soda,* and other purchased fertilisers are disappointing in their effects.

Similar cases might be given in which the entire crop seemed to owe its existence to the application of superphosphate. **The action of superphosphate** appears also to be due to its power of encouraging the growth of swedes and turnips when they are in the earliest stage of growth. A good "plant" or "braid" of turnips, showing up well in the rows, is highly important, and when once secured, the crop is usually safe. Superphosphate appears to ensure this, and to put the young turnips quickly beyond the reach of the turnip-fly. Without a dressing of superphosphate, the young plants are often swept away before they get their second or rough leaves, and hence, in all cases a moderate dressing of superphosphates ought to be given.

Dung and Superphosphate are, for reasons above given, considered to be the best manures for swedes and turnips, and in spite of much that has been written in favour of salts of potash, magnesia, soda, and of nitrates, it will be better to apply them to other crops, or in some rare condition of soil in which they may be required even for swedes and turnips.

Manuring the Mangel Crop.

Mangel-wurzel can produce a much heavier crop than either swedes or turnips. It has been known to

* As nitrate of soda is often reported of favourably as a manure for swedes, it is evident that nitrates in such cases must be deficient. In most cases, however, it is not to be recommended either for swedes or turnips.

yield one hundred tons per acre, and as it does not contain so large a quantity of water as the turnip or swede, the amount of dry material (and also of ash or mineral matter) which it takes from the soil is very much greater. Mangel is also generally carted off the land and stored in heaps, for the use of sheep and cattle in the spring, because it keeps well, and because it is not hardy enough to stand a severe frost if left unprotected in the fields. These two conditions of mangel cultivation—its need of plenty of food, and its removal from the land—point clearly to the conclusion that it must be heavily manured. We may indeed go farther, and say that good lands in good or high condition are particularly necessary for the production of a heavy crop of mangel. It has long been known that farmyard manure is one of the best applications for mangel, because this substance, when well made, contains nitrogen as well as the various mineral or earthy matters required for the perfect growth of the crop. It is difficult to overdo mangel with dressings of farmyard manure, and if thirty tons per acre can be spared, it will be found to pay. Such is, however, seldom the case, as one of the difficulties we have to contend with in farming is the limited supply of dung. Sixteen to twenty tons per acre are more ordinary dressings, supplemented with artificial or portable manures, such as superphosphate of lime, nitrate of soda, or sulphate of ammonia.

Superphosphate, although generally used, does not produce nearly the effect upon mangel-wurzel that it does upon turnips and swedes. In some cases it has even been known to lower the yield of the crop. As this is curious,

I will introduce a few figures taken from results obtained by Sir John Lawes. In the one case farmyard manure (fourteen tons per acre) was used, and in the other farmyard manure (fourteen tons per acre) with three and a half hundredweights of superphosphate. The average of four seasons, from 1881 to 1884, gave, from

Farmyard manure = 16 tons 15 cwts. per acre.
Farmyard manure and 3½ cwts. of Superphosphate } = 16 tons 12 cwts. per acre.

Other experiments which were made at the same time gave similar results, bearing out the idea that superphosphate is not effective when used upon mangel.

It does not, however, do to be too certain as to the effects of manures, because so much depends upon the nature of a soil and the peculiarities of a season. In soils where phosphoric acid is wanting, superphosphate might cause a great increase in the crop, and according to the practice of most good farmers, a little superphosphate—say, two hundredweights per acre—is almost always applied to mangel. The two portable or artificial manures which produce the heaviest crops of mangel are nitrate of soda and sulphate of ammonia; and both of them are best applied as top-dressings—*i.e.*, scattered over the surface after the plants have come up. Top-dressing is most beneficial to mangel when applied early in July, when the plants are almost meeting in the rows and are in full growth.

The great increase in a crop of mangel from a top-dressing of nitrate of soda or of sulphate of ammonia is readily shown by the following Table of Results obtained

at Rothamsted Park. The table also shows the small effect of superphosphate in comparison with that of these other substances.

	1876	1877	1878	1880	1881	1882	1883
	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.
1. 14 tons of Farmyard manure	19 12	15 7	13 5	18 11	13 15	14 14	22 12
2. 14 tons of Farmyard manure, 3½ cwts. of Superphosphate	19 13	16 14	14 16	17 8	15 2	15 18	18 19
3. 14 tons of Farmyard manure, 3½ cwts. of Superphosphate, 550 lbs. of Nitrate of Soda	27 13	26 8	21 4	27 16	19 12	25 2	28 15
4. 14 tons of Farmyard manure, 3½ cwts of Superphosphate, 400 lbs. of Ammonia Sulphate.	29 8	26 18	19 25	25 15	16 10	23 5	23 5

In the above trials nitrate of soda showed to the greatest advantage, and usually gave an increase of about ten tons per acre. This increase, if sold, would realise 20s. per ton, or if eaten by live stock at home would be at least worth 10s. per ton. The cost of 550 lbs. of nitrate of soda would be about £2 15s., so that the profit is evident. In most situations a liberal dressing of farmyard manure, to be followed later with a dressing of nitrate of soda upon the growing plants, may be relied upon to give good results.

Common salt may also be used as a manure for mangel-wurzel, especially upon dry soils and in dry summers. The best plan is to mix the nitrate of soda and salt together, and apply them to the crop in the proportion of three

hundredweights of nitrate and three hundredweights of salt per acre.

When soils are deficient in potash, about two to four hundredweights per acre of kainit, a salt rich in potash, may be broadcasted (scattered) over the land and ploughed in with the manure. As a general rule soils are not deficient in potash, so that cases are rare when kainit is needed.

Manuring Carrots and Parsnips.—These crops are usually manured with farmyard dung and superphosphate, as in the case of turnips. Being very deep rooted they depend more upon the richness of the soil, and the subsoil or under-soil, than upon dressings which can be given at the surface.

Manuring Rape, Kale, and Cabbages.—Superphosphate is as good for all these crops as it is for the closely-related turnips and swedes. Being leafy in their nature, they are also strongly acted upon by nitrate of soda, which manure always encourages or stimulates the growth of the leafy parts of plants. Nitrate of soda may be top dressed over rape, and dropped by hand in small pinches around the roots of kale and cabbages.

CHAPTER VII.

ROOT CROPS AND THEIR ENEMIES.

The first Difficulties of the Root Crop—Turnips and Swedes.

When the soil is moist and fine, and the weather warm, turnip seed soon germinates. It is, however, necessary that it should have these advantages, for if sown in a dry and coarse bed it will lie long without showing any sign of life, and when the young plants come up they will be likely to fall victims to the turnip-fly. Turnips and swedes first appear as two small round leaves, which in fact were wrapped up in the seed, and when they come to the surface they often bring the shell of the seed up with them, much in the same way as a newly-hatched chicken has been seen with an egg-shell on his back. These two leaves are also called cotyledons, as already mentioned in an earlier part of this book. Now as soon as these cotyledon leaves show themselves, they are subject to the attacks of a little insect which does thousands of pounds' worth of damage every season. This is the *Haltica nemorum* or Flea Beetle, a small insect which awaits the appearance of the young turnips, living meanwhile upon similar plants, such as charlock, or the white flowering Jack-by-the-hedge. In dry seasons few turnip fields escape these insects, and they often devour the leaves before they are through the ground. The commonest form of turnip-fly is the *Haltica nemorum*, which may be described as a small beetle of about one-twentieth of an inch long, furnished with hard wing cases, each of which is marked lengthways with a pale straw-coloured

band. The insect is possessed of wonderful jumping powers, which makes him difficult to capture, although means have been contrived by which he is made to jump into a trap. There is also a kind of turnip-flea of rounder form and entirely black. Few persons can have watched the cultivation of the turnip crop without having seen or heard of the turnip-fly, and, therefore, instead of taking up space with description, we shall consider the best means for checking his ravages, for so his attacks deserve to be called. First, then, anything which assists a rapid germination of the seed, and a quick passage through the earliest stages of growth prevents loss from the fly. As soon as the young turnip has exchanged its first lobe-like or round fleshy (cotyledon) leaves for its ordinary rough leaves, it is out of danger. The best conditions are good and new seed, a moist and fine condition of soil, and plenty of manure, and especially of superphosphate, to push the young plant forward. Good farming is therefore one of the best means of defeating the turnip-fly. Among other special means may be mentioned plenty of seed, *i.e.*, at least three pounds per acre; steeping the seed in oil of turpentine before sowing; dusting the young plants with a mixture of dry road dust mixed with quick lime, sulphur and soot,* and of late, the

* Mr. Fisher Hobbs' (at one time a noted agriculturist) receipt consisted of the following mixture:—

1 bushel of white gas-ashes fresh from the gas-works
1 ,, fresh lime from the kiln
6 lbs. of sulphur
10 ,, soot

well mixed together and reduced to a fine powder. This is dusted on to the young plants very early in the morning, before the dew rises, and is sufficient for two acres.

distribution of lime, or a solution of carbolic acid in water, by means of Strawson's air-power distributor, an instrument which we can at present no more than mention.

When turnips are attacked with the fly, it is a good plan to roll the surface occasionally with a light wooden roller. This disturbs the fly and allows the plants a chance of growing. Brush* harrowing may be recommended for the same reason. Another means which is easy and practical is to scatter a few pounds of mustard seed, or about three pounds of white turnip seed per acre over the surface, directly after drilling, and to harrow it in. This produces food for the hungry beetles, and takes their attention off the crop. In moist seasons these precautions are not needed, but in dry summers the farmer ought to provide against the attacks of the fly as far as he possibly can. When the turnips have got fairly into the rough or second leaf all danger from the fly is at an end.

Other Enemies of the Turnip Crop.

The wireworm (*Elater obscurus*, Fig. 11) begins his attacks somewhat later than the turnip-fly. No plague is better known or more dreaded by farmers, especially on the lighter sorts of soils. The wire-worm is the grub or larva, as it is called, of the click beetle or skip-jack, a longish brown beetle which most boys are familiar with. When caught and held between finger and thumb it makes a little click which can be both heard and felt, and is probably a natural means

* This is a primitive method of harrowing by means of thorns laced or wattled between the bars of a gate. The brush harrow so formed gives a very gentle tillage suitable for distributing dung on grass land or for such a purpose as is mentioned in the text. Brush harrows may also be employed for covering grass seeds when sown upon young barley. [Ed.]

of defence. When laid on their backs they regain their position with a jerk accompanied by a click. Click beetles are of several sorts, and are commonly about one-quarter inch long, and one-third of their length in width. They are mostly of brownish colour. The grub is straw coloured, smooth and jointed. It has a horny brown coloured head, and six legs at the fore part of the body. The female beetle lays her eggs

Larva of Elater.

Jumping organ of Elater, seen sideways.

Jumping organ of the Elater.

Fig. 11.—ELATERIDÆ.

just below the surface of the ground among roots and dead leaves. The grub lives for several years before it changes into the parent or beetle form, and during its whole life it does serious damage to crops. Its favourite haunt is old clover or seed fields, as well as old sainfoin and pasture, and when these fields are ploughed up they are often found to be infected with "worm" as many farmers call them. The wireworm eats around the young roots, being attracted by their sweetness, and at last reaches the centre, when the upper part of the plant becomes severed

from the root and dies. The best means of preventing the attacks of the wireworm is to prevent the female from laying her eggs in the best situation. Thus the treading of sheep when eating turnips upon the land is a good thing. Also a dressing of hot lime upon pastures about to be broken up, destroys eggs. The process known as paring and burning is often employed when land is thought to be full of wireworm. In this tillage operation the top soil is cut off at about two and a half inches in depth with a sort of plough called a paring plough. Or a common plough is used for the purpose fitted with a broad or wide share. This is called paring. The burning follows later, after the ground is dry, and is often put off until March or April. The field is well harrowed, and the roots of the grass and weeds are then found lying all over the surface. They are gathered together and burnt, and as much of the loose soil as possible is also thrown over the fires, which are dotted all over the land at only a few yards apart. In this way the upper two or three inches of the soil are burnt, or at least well roasted, and by this means thousands of wireworms and their eggs are destroyed. The ground is then got ready for turnips. Autumn cultivation (page 35) is also a good means of getting rid of wireworm.

When a crop is found to be affected, heavy rolling is very beneficial, as it renders the soil firm and stops the runs which the worms make under the surface. A top dressing of salt, at the rate of six to eight hundredweights per acre, is also beneficial. Strong fertilisers, such as nitrate of soda, guano, and superphosphate, assist the crop to outgrow the attack. Rape cake, if applied as a dressing to

land, is said to take off the attention of the wireworm from the crop, as the grubs are fond of rape cake. Lastly, we cannot too much impress the importance of salt, soot, gas-lime, and hot lime, as most excellent when ploughed into land affected with wireworm, or with any other insect plague.

The Black Caterpillar, or the black Jack, is the larval form, or, in other words, the caterpillar, or grub, of a pale yellow, four-winged saw-fly, known as the *Athalia Spinarum* (Fig. 12). This fly lays her eggs upon the under side of turnip leaves, and in a few days the caterpillars are hatched. They grow and change their skins (moult) repeatedly, and at last become about a quarter of an inch in length. These caterpillars cannot be mistaken, as they are dull black in colour, with a lighter stripe on each side. They feed with their tails raised, and are generally found affecting spots, and not distributed evenly over the whole field. Fortunately, many years may pass over without a visit from the black Jack. The best means for getting rid of them are driving sheep repeatedly over the affected spots, hand picking, brush harrowing, and penning flocks of ducks and chickens, when they can be procured, on the affected parts of the field. **Strawsonising**, or the use of Mr. Strawson's air power distributor, which has already been mentioned, would probably make short work of these caterpillars by *spraying* them with a fine spray of carbolic

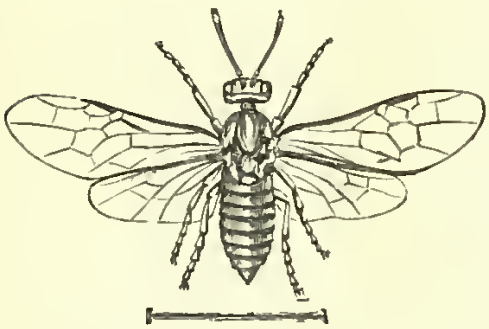


Fig. 12.—ATHALIA SPINARUM.

acid dissolved in water, or covering them with a shower of fine, hot lime.

Surface Grubs.—Still later in the life of the turnip crop it is apt to be attacked by a class of grubs known as surface Grubs or Leather-jackets, owing to their tough skin and brown or tanned appearance. These caterpillars are of large size, and very thick in body, so that they are readily seen. They are generally found about one inch beneath the surface, and close to the turnip or mangel which they are feeding upon. The first thing that strikes us is the flagging or drooping condition of the leaves of a turnip or other plant, and on stooping down we see that the soil close to the root is moist from the escape of sap. On removing the soil with the finger the grubs are discovered—sometimes as many as twelve being found at one root. They are unpleasant-looking creatures, but from their size, and owing also to the fact that they are easily found, they may be readily collected into pots or tins and removed. Starlings, rooks, and lapwings also feed upon them, and it is well not to disturb flocks of these birds if seen to be inclined to settle upon fields so affected. The surface grubs are the caterpillar or larval form of several sorts of night moths, hence known by the family name of *Noctua* (Fig. 13). It includes *Noctua* (*Agrotis*) *segitum*, the common Dart Moth, *Noctua* (*Triphœna*) *pronuba*, the Yellow Underwing Moth, *Noctua* (*Agrotis*) *exclamationis*, the Heart and Dart Moth. All of these species or sorts of moths breed surface grubs

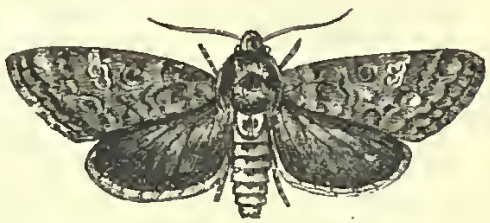


Fig. 13.—NOCTUA.

or leather-jackets. Besides hand picking, the best preventive consists in deep, and somewhat late autumn ploughing, and if soot, salt, or gas-lime are ploughed into the ground at the same time, the work will be still more effective. Soot is one of the best means at our disposal for preventing almost all sorts of insect attacks.

Green Fly or Aphis (plant lice) (Figs. 14 and 15). These well-known little insects are often called "blight."

Fig. 14.—WINGED APHIS (natural size).

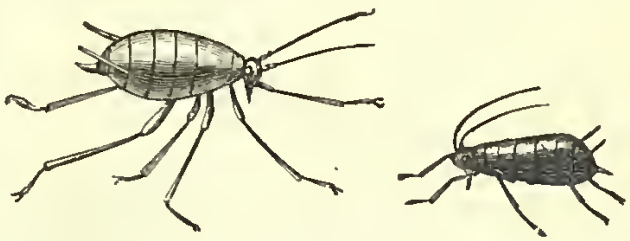


Fig. 15.—WINGLESS APHIS (natural size).

They are to be seen on roses, apples, pears, and fruit trees generally, and upon almost all sorts of crops. They often appear after cloudy weather, and what gardeners call blighty winds. We must not, however, think for a moment that such blighty weather *breeds* insects. The green fly no doubt is more general in certain kinds of weather; and, like all insect attacks, it is due to suitable conditions, and abundance of food, causing a rapid increase in their numbers. When these favourable conditions are present, the eggs hatch without difficulty; and as the broods quickly mature or come to full age, they in turn multiply, and thus it comes to pass that we suffer from a plague of insects.

The history of the group of insects known as Aphides, or plant lice, is curious, and as it is given in very simple language by Miss E. Ormerod, we cannot

do better than to quote from her. She tells us that although named A-phides or wingless, it is only the females which may be so spoken of. The males are winged, and are much prettier than the fat, round, wingless females known as plant lice. These females, which are produced very soon after the males in autumn, lay eggs sometimes singly, sometimes in clusters. From these eggs, in the following spring (or possibly before) young aphides hatch, which are all females; they go quickly through their changes (that is from the egg to the larva or grub stage; from the caterpillar to the chrysalis, and from the chrysalis to the perfect form) up to the mature state, *and then they produce living young*, which are all females. Successive generations of living young, *still all females*, some winged and some wingless, go on, until in autumn the last generation occurs, which consists of males as well as females, and the females of this, as we said before, instead of producing living young, produce eggs, which start the next year's attack.* This is very curious indeed. Chickens are hatched from eggs, and lambs and calves are born alive, but here is an insect which lays eggs in autumn, produces its young alive for several generations, and finally the descendants begin to lay eggs again. If, however, my readers wish to study this deeply-interesting matter further, they must not be content with this simple description, which is made as easy as possible.

The aphides collect together on the under sides of the turnip leaves, and their presence is soon shown by the puckered or cockled appearance of the leaf, and a blue colour in the place of a healthy green. On plucking

* "Methods of Insect Life." Ormerod.

the leaf it is found to be infested with plant lice on the under-side. Owing to the peculiar method of multiplying, already mentioned, the aphides increase from spots, over wider and wider areas. The first colony continues to produce wingless females which take possession of neighbouring plants, and thus the plague gradually spreads itself. This shows the great importance of at once pulling any plant which is discovered to be affected, and removing it from the field and burying or completely destroying it. By carefully looking over a field when the attack is observed, and removing all the affected plants (each of which would become a centre for spreading the attack) much harm may be prevented. The injury to the growth of the crop is caused by the loss of juice or sap which the insects require for their nourishment, and to the sticky honey-like matter which these creatures deposit upon the leaves called "honey-dew," which checks the breathing powers of the leaf.

DISEASES OF THE ROOT CROP.

Turnips and Swedes are liable to diseases as well as insect attacks. In dry weather and especially when they have been too early sown, turnips and swedes suffer from mildew, which may be described as a white mould which forms a crust over the entire leaf.

This mould smells of mushrooms, and is really a fungus, although of very small size. It strikes its roots into the leaves and feeds upon its juices, and in the end destroys them. This is a serious thing for the crop, because the leaves of a plant are its lungs by which it takes in

oxygen from the air and absorbs gases, which it changes into vegetable growth such as wood, straw, root, or grain. In this case the crust which spreads over the leaf stops the growth of the turnip, and would do so entirely except for the fact that new leaves are formed at the centre, and these leaves grow and expand, and take the place of the dead leaves, after which the turnip root again begins to swell. Mildew is therefore to be looked upon rather as a check to growth than as a destructive disease. It is, however, too often found that after a severe attack of mildew the crop of roots is liable to rot, and that consequently their keeping properties are injured.

Anbury or Clubbing.—Sometimes turnips, swedes, and also cabbages, are found to be affected with anbury. On taking one of them up, it is found to be suffering from clubbing, by which is meant that the root fibres or small rootlets have become enlarged at the ends into little knobs, or what are also called excrescences. These knobs take the place of the little mouths by which the root fibres suck in sap from the soil. They in this manner stop the growth of the plant and become very injurious and even fatal to the crop. It is believed that this disease is caused by the attack of an extremely minute fungus which completely fills the minute *cells* which form the substance of the root fibres. These cells are in themselves well worth studying. They are so named because they are something like the cells which make up a honeycomb, but are very much smaller. They make up the entire plant. They are hollow and filled with fluid, as may be seen on examining the inside of an orange, when the juice will be seen to be contained in rather large cells, so that an orange may be

torn in pieces without losing a drop of liquid. In a turnip the cells are very much smaller, but can be seen with a microscope. When a turnip is attacked with anbury the cells become the home of a still more minute fungus which swells them up, and as this goes on in thousands and millions of cells all at the same time, we find an enlarged knob which destroys the power of the small roots to feed. In studying the diseases of crops, people are generally more interested in the cure than they are in the causes of the disease, but it is necessary to know the cause before we can know how to cure. For this reason scientific men study diseases with the help of the microscope, and having found out the cause, they are then better able to say how the disease should be treated.

One of the best ways to prevent anbury is to add lime to the soil, and although not easy to see why, we know that lime destroys the fungus which causes the mischief. If lime or chalk is added to land which is liable to clubbing or anbury, we shall not be troubled with it again.

The Turnip Gall-Weevil (Fig. 16) is a small beetle which causes a number of galls or little risings (excrescences) all over the turnip and this is sometimes mistaken for anbury. It is however due to quite a different cause, and is not a serious ailment. If one of the galls or wart-like swellings is cut into, a small maggot is found, which is the larva or grub of the turnip gall weevil (*Centorhynchus sulcicollis*).

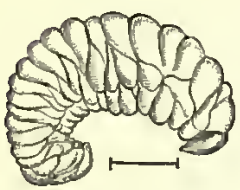


Fig. 16.—TURNIP GALL WEEVIL.

Finger-and-toe is not strictly speaking a disease. The term, it is true, is sometimes used to describe anbury, but the true cause of finger-and-toe is an imperfect growth

of the plant, due to the use of inferior seed. All our cultivated plants need a great deal of care to keep them up to the proper standard. They have been improved by cultivation, and if badly treated they are apt to degenerate or go back to the original wild form. This is probably the cause of finger-and-toe. It is seen in the form of a number of fangs, or a divided root, instead of a nice round and well-shaped turnip. As these fangs sometimes look rather like fingers and toes it is not difficult to see how the name originated. Finger-and-toe is then prevented by sowing the best seed and taking pains with the cultivation of the plant.

Other Insect Attacks.

Mangel-wurzel, which next to turnips is the most important of the so-called root crops, is subject to few

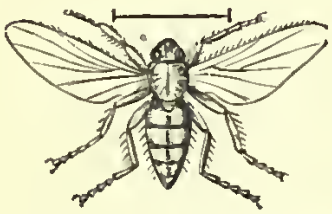


Fig. 17.—MANGEL FLY.

Fig. 18.—CABBAGE CATERPILLAR.

diseases or attacks. There is, however, the two-winged beet-fly which is known as the *Anthomyia betæ* (Fig. 17), but it is seldom that it does great harm. The caterpillar of this fly is a miner, and burrows between the upper and lower skins of the leaf, feeding upon the green matter which forms the body of the leaf.

Cabbages are attacked by the caterpillar of *Pieris*

(*Pontia*) *brassicæ* (Fig. 18), the common white butterfly, and carrots suffer from the carrot fly (*Psilarosæ*). It is difficult to say how these pests are to be destroyed. Happily in the order of nature there are not only animals and birds of prey but insects of prey also. These are named Ichneumou flies. They are so called after a class of animals allied to the civet cats, and especially after the best known species or kind of ichueumon common in Northern Egypt, which feeds upon the eggs of the crocodile. This animal was an object of worship in ancient Egypt. It is grey in colour and larger than a weasel, and has a tuft of hair at the end of its tail. It has been called Pharaoh's rat, and it is scarcely necessary to say that an animal which reduced and moderated the number of crocodiles in the Nile must have been looked upon with respect, and for this reason was au object of worship in ancient Egypt. The ichneumon flies resemble the ichneumon of the Nile only in the fact that they are creatures of prey. The eggs of the ichneumon flies are laid in the bodies of caterpillars, and after hatching, the young ones feed upon and finally destroy their *hosts*, as the receiving bodies are appropriately termed. Almost every insect which attacks our crops is followed by a corresponding ichueumon, and thus they are prevented from multiplying to the extent which they might, if there were no ichneumon flies. Thus the Cabbage Ichneumon fly lays a vast number of eggs, sometimes as many as sixty, in the caterpillar of the Cabbage Butterfly. It is very strange that in feeding upon their *host* the ichneumon maggots never attack their vital parts. This is a provision of Nature, for were the host to die too soon, all the ichneumons which live upon it would perish. Auother

ichneumon attacks the green-veined Cabbage Butterfly. The wheat midge is accompanied by a parasite or ichneumon fly, and the *Platygaster* lays an egg in every grub of the wheat midge which it can find.

The best means at the farmer's disposal have been already mentioned, but we may repeat the following methods, which should not be neglected. Good cultivation, and especially autumn and winter ploughing; the destruction of all weeds; keeping hedgerows clear of weeds and grass; burning weeds and stubble; using hot lime, salt, soot, and gas-lime as applications or dressings to the land or to affected crops; heavy rolling; brush harrowing; etc. Happily the means for destroying insects are generally in harmony with the best rules of thoroughly good farming.

Time for sowing the various Root Crops.

It is important that each crop should be sown at the most suitable time of year. It is not necessary to fix upon a particular day or week, and in fact it would be impossible to do so, as seasons vary in their character from year to year. The best period for sowing a crop may therefore be considered to shift according to the earliness or lateness of the season by about a fortnight.

The locality also makes a difference, the tendency in the case of the root crops being towards greater earliness as we travel northwards. Similarly, on high situations, sowing ought to be done earlier than in sheltered and favoured places. The following dates are fixed upon as suitable for sowing these crops in the South of England, the Midlands, and the North of England :—

	Counties South of London.	Midland Counties.	Northern Counties.
Swedish turnips	June 1 to 15	May 25 to June 8	May 13 to 27.
White turnips	June 15 to July 15	June 8 to July 8	June 1 to 20.
Mangel-wurzel	April 21 to May 1	April 21 to May 1	April 21 to May 1.

White turnips are sown over a longer period than either swedes or mangel, because they are required for a greater number of purposes. Thus early white turnips for feeding sheep in August and September may be sown in May. For main crop the times above given are very suitable, while for late turnips which are to supply green food in the early spring through the growth of their leaves, sowing may be continued throughout August.

METHODS OF SOWING.

The root crops are always sown in rows of from fifteen to thirty inches apart. The narrower rows are used for late sown turnips, when there is not much chance of a large crop. Also upon poor land the rows need not be very wide apart. When the season is early, and the land is likely to produce a heavy weight of roots, the distance can be extended according to the farmer's judgment. Mangel-wurzel, as the heaviest of all the root crops, requires to be planted in rows of from twenty-five to thirty inches apart; swedes may be drilled at from twenty to twenty-seven inches apart; white turnips in rows of from eighteen to twenty-five inches wide. Upon the same principle the distance at which the plants are left apart *in the rows* is regulated by the kind of root, the quality of the soil, and the time of year. (*See* Singling.)

The most common way of sowing turnips and other

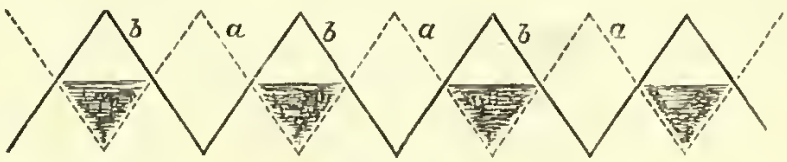
root crops is by drilling. When turnips were first grown as farm crops in this country (about the year 1690), they were sown broadcast. We owe the drill to a Berkshire yeoman named Jethro Tull (see page 67), who was a barrister, a man of education, and a great thinker. He was a musician, and often played the organ, and he tells us in his book on "Horse-Hoeing Husbandry," that it was while playing the organ that he first thought of the drill. The pipes placed at regular intervals in the organ gave him the idea of drilling seed by a set of pipes fixed upon a frame drawn by horses. The principle of sowing in rows instead of broadcasting is thoroughly sound, and we now seldom sow any of our root crops otherwise.

There are several ways of drilling. First, there is the north country plan of sowing on raised ridges. The land is raised up by the plough in rows about twenty-seven inches apart, giving the appearance of the sketch on the following page (Fig. 19).

The dung is then carted on to the land and spread in the bottoms of the ridges, which are then split over the dung by the plough. This plan is often followed in potato planting, the potatoes being laid on the dung, and the ridges split so as to bury the sets. The turnip seed in this system is sown by means of a two-row turnip drill upon the tops of the ridges. A picture of this implement is shown at Fig. 20.

Sowing on the ridge is only suitable for moist and cool climates, and upon soils which do not dry quickly. In the drier climate of the South of England drilling on the flat upon a finely prepared and rolled surface is preferred, and

Fig. 19.—Showing the Northumberland method of raising and splitting ridges, at the bottom of which the dung is deposited; *a a a* shows in dotted lines the ridges as first raised 27″ apart: *b b b* shows the ridges split.



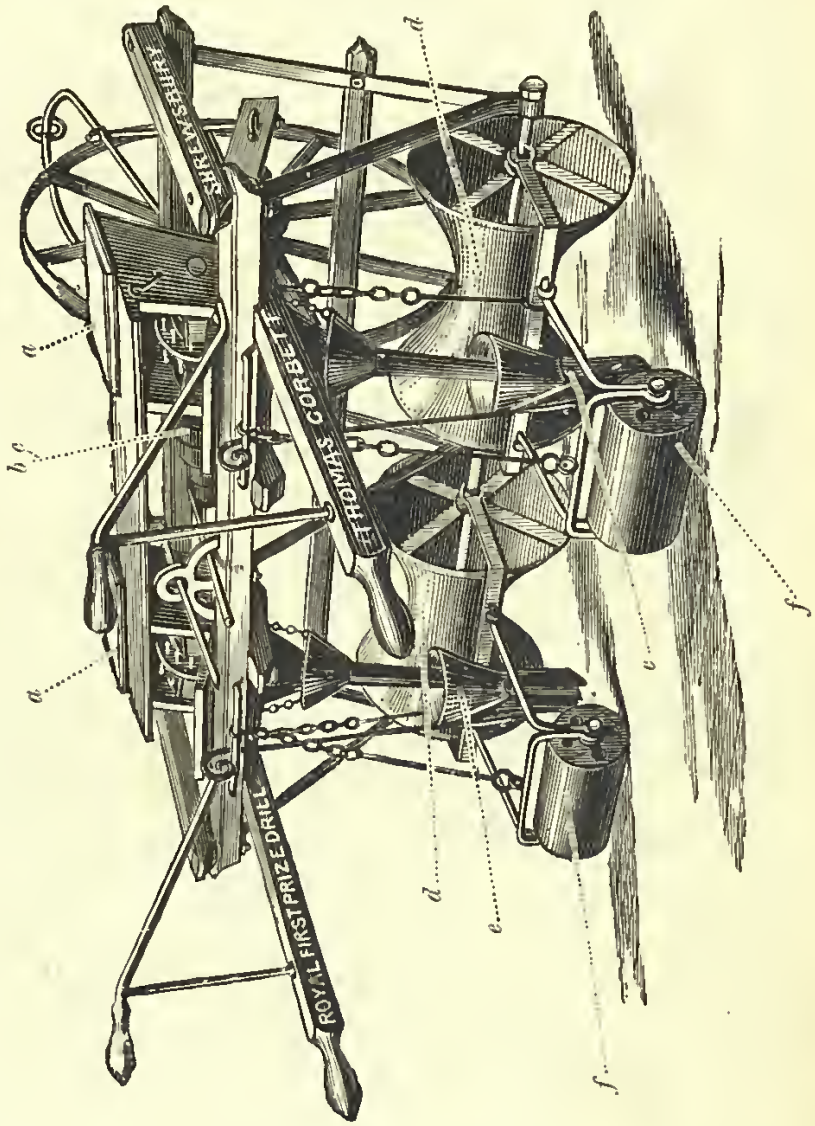


Fig. 20.—Improved two-row turnip drill for raised ridges.

a a, Seed boxes or hoppers; *b*, strap to work seed barrel; *c*, pulley for turning seed barrel; *d d*, concave iron rollers for fitting raised ridges; *e e*, coulters for depositing seed; *f f*, small rollers for covering the seed.

the seed is deposited by a drill capable of sowing five or six rows at once.

When this method is followed the farmyard manure is first spread upon the surface of the field and ploughed in. The land is then well dragged, harrowed, and rolled, and the superphosphate is mixed with ashes and drilled in with the seed.

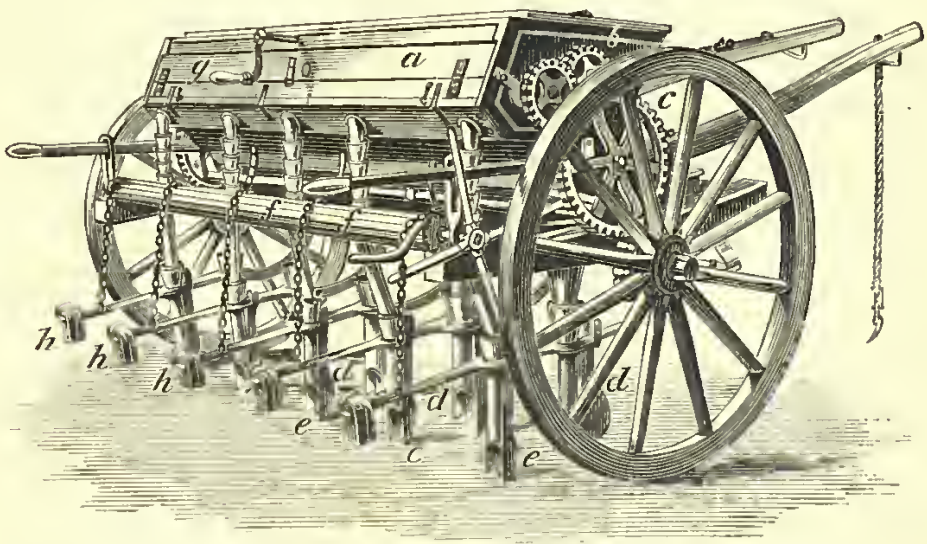


Fig. 21.—DRILL FOR SOWING TURNIP SEED AND SUPERPHOSPHATE.

a, Seed box; *b*, manure box; *c*, gearing, worked from travelling for wheel for turning seed and manure barrels; *d d d*, coulters for depositing manure; *e e e*, coulters for depositing seed; *f f*, roller with chains for lifting coulters out of the ground; *g*, lever for altering level of seed and manure boxes; *h h h*, weights for keeping coulters steady in work.

A Wiltshire farmer named Chandler invented a water drill, by which from 200 to 800 gallons of water per acre can be distributed with the seed. The water is carried in a tank at the back of the seed box, and the superphosphate is mixed with the water in the tank, and the water and

manure are distributed by revolving cups placed upon the outer edge of large wheels. The liquid is then lifted from the tank and conveyed to the ground through pipes ending in strong coulters, which make grooves in the ground for the reception of both seed and liquid manure (Fig. 21).

The advantage of the liquid manure or water drill is that the seed germinates more quickly. On the other hand, it has been noticed that in extremely dry summers, like 1868, 1870, and 1887, the water has not been an advantage, as it caused rapid germination of the seed at a time when there was not enough moisture to carry on the young plants. The water or liquid manure drill is commonly used in the southern counties, but has never made its way in the north or in Scotland.

Cultivating (hoeing) the Root Crops.

Just as it is of great importance that land should be clean, or clear from weeds, when the root crops are sown, so it is necessary to keep it clean during their entire growth. This is done by the use of the hand-hoe and horse-hoe. The former instrument is so familiar as scarcely to need a description. The two usual forms are the push hoe and the Dutch hoe, but the latter is chiefly used.

The horse-hoe (Figs. 22 and 23) consists of several knives, which are supported upon iron stalks and attached to a frame. Horse-hoes may be made for hoeing one row at a time, in which case they only have one wheel; or for taking several rows, in which case they are furnished with two wheels. What is called the after cultivation of roots, *i.e.*, of turnips, swedes, mangel, cabbages, rape, kale, and all the crops usually cultivated on cropped fallows—consists in re-

peatedly hand- and horse-hoeing them. The hand-hoe is used for working between the plants, while the horse-hoe is employed to move the spaee between the rows. The steerage, or apparatus for guiding the horse-hoe, is the same as that used for the drill. It is not neeessary to have more than one steerage part for the two instruments, as it is exehangeable.

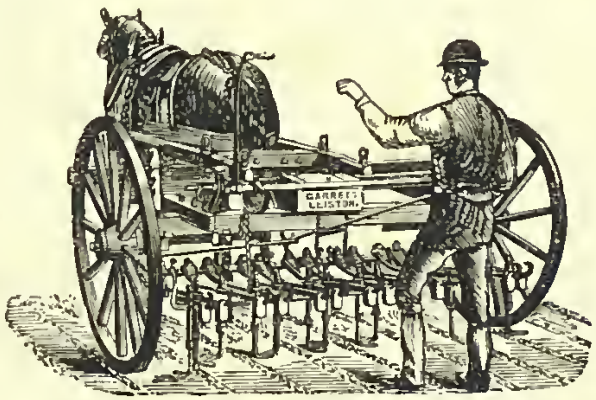


Fig. 22.—IMPROVED LEVER HORSE-HOE.

One of the advantages of the raised ridge system of sowing turnips is that the position of the seed is known, as it eorresponds with the top of eaeh ridge. It is for this reason possible to hoe the sides of the ridges *before* the young plants appear, and in this way to keep down the crop of small weeds which sometimes are in danger of completely smothering the young turnips or mangel. Even the horse-hoe may be used for this purpose, and as the ridges are always of considerable width (twenty-five to thirty inehes) a single-row horse-hoe, or "seuffler," is the best and most thorough instrument. At twenty-seven inches apart a scuffler with one horse and held by a man, should get over four acres per day.

The usual practice is to give three horse-hoeings and two hand-hoeings, but in the northern counties and Scotland three horse-hoeings and three hand-hoeings. The reason of this difference is that there is a longer interval of time between the sowing of the root crop and harvest in the north.

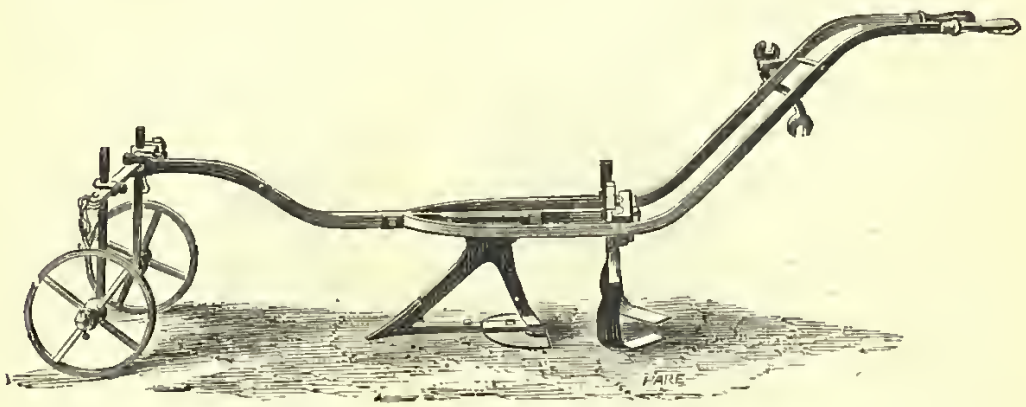


Fig. 23.—IMPROVED HORSE-HOE.

The after cultivation of root crops is done in the following order:—

1st. Harrowing with the ordinary or, even, a heavy drag harrow, as soon as the plants are well into the rough leaf. This pulls out surplus plants and thus makes hand-hoeing easier. It also destroys weeds and moves the soil.

Moving the soil is one of the most important points in cultivating the root crop. Contrary to what might be expected, it helps to keep the soil moist by preventing evaporation from the surface. The covering of fine loose soil acts as a blanket upon the under soil, preserving it in a warm and moist condition. The extraordinary effect of hoeing upon the growth of rape and turnips has often been noticed.

2nd. The first horse-hoeing follows immediately.

3rd. Singling or setting, which consists in carefully cutting out all surplus or needless plants and leaving the remainder at intervals of from one foot to eighteen inches apart, according to the nature of the crop, and the circumstances of soil, climate, and season.

4th. After an interval of about a fortnight, or longer, a second horse-hoeing.

5th. A second hand-hoeing is usually given when the leaves are almost touching each other across the rows. In this operation all needless plants left in the first hand-hoeing are removed, all weeds are cut out, and the soil moved between and around each plant.

6th. The third horse hoeing is given when the leaves are well met in the rows.

7th. The third hand-hoeing is given immediately after the third horse-hoeing, and the land being now completely covered with a mass of vegetation, no more hoeing is required.

These after cultivations are more thoroughly carried out in the north than in the south, and south country farmers and bailiffs would do well to take a lesson in root cultivation from their north country brethren.

When a top dressing of nitrate of soda is given it is best applied about the time of the second hoeing.

FODDER CROPS, CULTIVATED ON FALLOWS.

Fodder crops are cultivated for their leaves or stems, and may be either mown and carried to horses and cattle or may be eaten upon the land by sheep. In either case they are beneficial to the farm, because they are returned in the form of manure, and what is actually removed in the milk, beef, mutton or wool sold off the farm is fully made up by the cake and corn which the live stock receive in addition.

On clay lands some of these fodder crops may be cut and preserved as *silage, i.e.*, fresh, by crushing them into air-tight pits. Some people are much in favour of this system of using fodder crops. Clay lands are not always suitable for "root" crops, but are well adapted for vetches,

clover, or a mixture of beans, oats, and vetches, which yield a large quantity of useful forage.

After mowing and removing such crops for silage, the land can be cleaned and prepared for wheat, and thus the treading of sheep in the winter, or the pressure of horses and carts in removing root crops in wet weather is avoided.

On light lands both fodder and root crops may be grown, and it is a common practice to sow a fodder crop in early autumn and feed it off in spring. The land is then ploughed up and prepared for "roots," and thus two crops are secured in one season, and the fodder crop is spoken of as a "eateh" or "stolen" crop. On the light sheep farms of Wilts and Hants this is a usual manner of cultivation. (*See* page 22.)

The principal Fodder Crops employed in the above manner are vetches, winter rye, winter barley, winter oats, and trifolium; white mustard is also used, but differs in one important respect from the others, in not standing the winter's frost; but as it is very quick in growing, it may be sown and fed off within a period of about six weeks during autumn.

Cabbages, rape, kale, kohl-rabi, sprouting broccoli, and other leafy members of the cabbage family, are also properly speaking fodder crops, but as they occupy the ground for a longer period and resemble the root crops in many respects, their cultivation is generally described with the root crops. Leaving these last-named plants out of consideration, we find that the general management of the fodder crops is very simple; a clean wheat stubble may be dunged with a light coat of about twelve cart-

loads per acre, and, after spreading, the land is ploughed about five inches deep.

The surface is then well harrowed, and the seed is drilled and harrowed in.

Fig. 24.—VETCH (*Vicia termifolia*).

If the stubble should be foul, it must be first prepared by the usual processes of autumn cleaning, and then the dung is carted on and ploughed in as described.

Vetches (Fig. 24) are drilled at the rate of two and a half bushels per acre with half a bushel of winter barley, the drill coulters being set so as to deposit the seed seven inches apart between the rows.

Vetches should be sown at intervals during September, October, and November, and spring vetches may be sown in February, March, and April, and thus be made to furnish a succession of fresh food from May to October.

Winter Rye, Barley, or Oats, are drilled at the same distance apart, and at the rate of two and a half to three bushels per acre.

These winter cereals should all be sown early in September.

Trifolium is the most easily cultivated of any crop, but is only grown in the south of England. All that is required on clean stubbles is to well harrow the surface, and then to broadcast the seed at the rate of twenty pounds per acre. Harrows are then employed to cover up the seed, and the last operation consists in rolling the surface with a heavy iron roller. Trifolium ought to be sown in August or early in September.

CHAPTER VIII.

CORN CROPS.

Wheat.

Wheat is the most important of all the cereals. It grows in such tropical countries as Venezuela, and abundantly in Australia, India, Ceylon, and Egypt. It is produced in great perfection in southern and middle Europe and in Canada, and is apparently capable of thriving in latitudes extending from the tenth to the sixtieth parallels.

In 1890 about 2,544,550 acres of wheat were grown in the United Kingdom, and large as this area appears, it is small compared with the 37,000,000 acres grown in the United States, the 27,000,000 acres grown in India, the 10,000,000 acres grown in Austro-Hungary or the 17,000,000 acres grown in France. The large quantity of wheat produced of late years throughout the world has made it very cheap, and although this has been a loss to English growers, there can be no doubt that the cheapness of bread has been a great blessing to the working classes of this country.

Although wheat is so widely grown, it is somewhat strange that no one knows from what wild plant it originally sprung. Whether wheat has always been wheat, or whether, like apples, turnips, beet, and other fruits and vegetables, it has been produced from a wild plant by cultivation, no one seems able to say. Not only is there no true wild wheat, but there is no grass or kindred plant which can be looked upon with the least certainty as the parent form from which wheat is descended. The oldest examples of wheat in the world have been found in Egyptian tombs, or have been preserved as charred grain

at the bottom of Swiss lakes, from the sites of human dwellings which are considered to be of very remote age.

The number of kinds of wheat is very great. One naturalist, Phillipar, possessed three hundred and twenty-two varieties (Darwin), and it is stated on good authority that all varieties may be depended upon to breed true to their kind.

We have not space to describe even a few of these varieties of wheat. The differences are often minute or are difficult to explain in words.

Wheat belongs to a family or genus of grasses known as Triticum, from the Latin *tritum*, rubbed or worn, owing to its being ground. One of our most common weeds, couch-grass, belongs to the same genus, and from its hidden habit of growth is termed *T. repens*. There are seven species or quite distinct kinds of wheat (Fig. 25), to which the vast number of sorts or varieties already alluded to belong. The reader should perhaps be made aware that a species may contain many varieties; as, for example, the many kinds of pigeons which all belong to one species. So also the many breeds of chickens, of ducks, or of geese, in our poultry yards, each and all belong to species of which they are only varieties. So also most of our English breeds or varieties of wheat all belong to one species known as *Triticum sativum*. The seven distinct species of wheat are :—

Triticum sativum—common wheat.
T. turgidum—turgid (cone) wheat.
T. durum—hard wheat.
T. Polonicum—Polish wheat.
T. spelta—spelt wheat.
T. amyleum—starchy wheat.
T. monococcum—one-rowed wheat.

Of these, *T. sativum* is by far the most important. It is at once divided into two leading groups, the red and the white wheats. So far as the grain is concerned it is often difficult to distinguish different sorts of wheat, but

1. Triticum sativum. 2. T. turgidum. 3. T. durum. 4. T. Polonicum. 5. T. spelta. 6. T. amyleum. 7. T. monococcum.

Fig. 25.—WHEAT.

when the entire plant is seen the task is much easier. A few examples will show the differences which exist, and give character to the different varieties of *T. sativum*.

First, then, we have bearded and beardless wheats; as for example, Sheriff's Bearded Red and Sheriff's Bearded

White. Next we find rough and smooth ehaffed wheats giving woolly-eared, velvet-eared, and rough-ehaff Essex wheat. In some eases we have red-ehaffed whites, and in others white-ehaffed reds. In some the ear is long and straggling, in others close or clubbed, giving sprat and club-eared wheats. Also square-headed wheats, like Scholey's Square Head, and round-eared wheats like White Lammas and Red Lammas. Some are slightly bearded on the top of the ear, like Fenton or Chidham wheat. Some are long strawed, and some short strawed. Some are broader in the leaf than others, like Talavera. Besides these visible charaeters, there are others whieh affect the habits of the plant, and these differences give winter and spring wheats and hardy and less hardy varieties. With sueh a number of direetions in whieh wheats differ from one another it is no wonder that there are almost endless varieties.

The several sorts of eone wheats belong to *T. turgidum*. They are eoarse and bearded, and yield a large quantity of grain of poor quality, but are mueh grown in some distriets where the finer kinds would not thrive. Of late years a new series or elass of wheats has been produeed by erossing, and these erossed wheats are said to be superior to either parent form. There seems, therefore, every likelihood that we shall see no diminution, but rather an inerease, in the number of eultivated kinds of wheat.

Wheat may be grown upon all soils, except the lightest or sandiest, but it prefers the stronger or more elayey soils. For this reason elay land is usually spoken of as "wheat land"; and as beans thrive best on the same elass of sorts, as "wheat and bean land." Whatever land it is grown

upon, it is important that the soil should be in good condition, or rich from previous treatment. Our climate is not naturally suitable for wheat, being somewhat damp for producing the best qualities, and it is requisite to make up for these natural disadvantages by liberal treatment. Good wheat seasons are few and far between, and taking the last thirty years they may be said to have occurred in 1864, 1868, 1870, 1874, 1880, and 1887, that is about six times in thirty years.

Wheat is grown in the following positions in rotations of crops: after bare fallow, after roots, after clover, and after beans. Each of these places is suitable, as the land is at such times rich, and full of plant food, especially of nitrates. Clover and beans appear to be able to store up a large amount of nitrogen in the surface soil, and are exceedingly good preparations for wheat. The Norfolk rotation provides that wheat should follow clover as the fourth, and last crop, before the land again comes into roots.

Beans are similar to clover, as both are podded (leguminous) plants, and both possess the power of removing nitrogen directly or indirectly from the air, and storing it in the surface soil, where it soon becomes converted into plant food.

It is well known that the heavier the crop of clover is the better are the prospects of the wheat crop which follows, and this is accounted for by the larger amount of clover roots left in the land by a heavy crop. The fall of clover leaf (or of bean leaf when beans are taken instead of clover) is also much greater in the case of a heavy than of a light crop.

In Northumberland wheat is more generally taken after turnips, either after folding sheep upon them, or after they have been carted off for stock. In the first case the land is at once enriched by the sheep manure, but in the latter case it is evident that if the turnips are carted off the land farm-yard manure in sufficient quantity should be added to make up the loss.

When wheat is taken after potatoes, or after mangel-wurzel removed off the land, it is necessary to treat the field more liberally than when the root crop has been fed off by sheep.

THE CULTIVATION OF WHEAT.

The cultivation of wheat, and of all corn crops, is much simpler than that of fallow or root crops. In a small book treating of a large subject, we must try to avoid repetition as much as possible; and the reader may therefore be asked to refer to some remarks, here introduced, upon the general principles of corn cultivation, including that of wheat, barley, oats, beans, and peas.

The immediate preparation of land for corn is neither difficult nor expensive. When we say *immediate* we refer to the fact that many of our root crops are grown purposely to prepare land for corn. Such being the case it might be reasonable to look upon the tillages for roots as *indirectly* preparation for corn. The same holds good when wheat is taken after a bare fallow, for then all the many tillages required are really undertaken for the sake of the corn. Still the immediate tillages for corn are, in themselves, simple, and may be expressed by the following routine :—

Dung the land.
Plough and press.
Sow the seed with a broadcast machine.
Harrow it in.

Or if the drill is used the order is slightly altered as follows :—

Dung the land.
Plough.
Repeatedly harrow.
Drill the seed.
Harrow it in.

Ploughing for Corn.

For wheat we plough four or five inches deep, because the plant prefers a firm condition of the subsoil, and because as a general principle in farming *all corn crops thrive best in a well-worked seed-bed underlaid by a firm or solid bottom.*

If any one should think that this advice is inconsistent with deep or thorough tillage of land, let him remember that *all root crops thrive best upon a deep and somewhat loose seed bed.* The land is therefore deeply tilled during the rotation of crops, but not just before sowing a corn crop.

Pressing the Furrow.

After land has been ploughed up from clover or grass, the furrow lies a little too light or hollow, and it is necessary to consolidate it. This is done either by the land presser (Fig. 26), or by a heavy iron roller (Fig. 27). The two-wheel or three-wheel presser is made to follow two or three ploughs, and it leaves neat grooves into which the seed falls, so that after pressing and broadcasting, the corn comes up in rows about nine inches apart.

When the heavy roller is used, the whole of the ground is made solid, and the surface is then well harrowed, and the seed is drilled in with a corn drill.

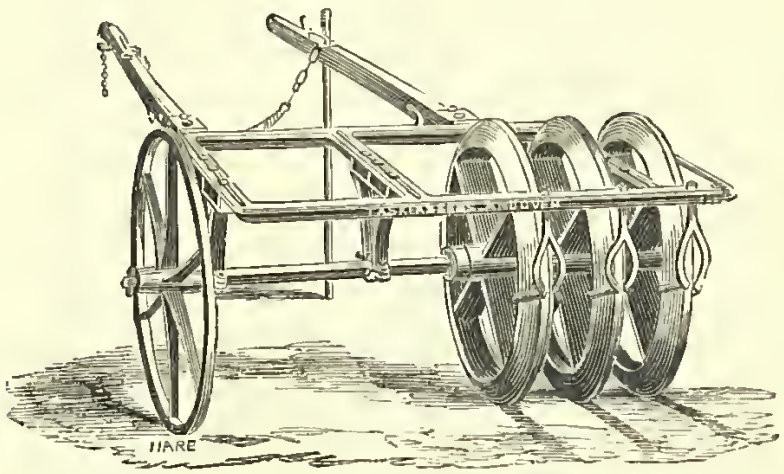


Fig. 26.—LAND PRESSER.

Harrowing for Corn.—We can scarcely harrow land too much for a corn crop. The effect of repeated harrowing is that the top soil is made fine and loose, while the under soil is made firm, which is the proper condition of a seed-bed for corn.

Exceptions.—Although pressing the furrow is always* done on clover land, it is not necessary in a ploughed surface after mangel or other root crops. In such cases the simple cultivation first mentioned is sufficient, and is generally followed. Dunging is also usually omitted after a root crop, for the reason that the land has been recently dunged.

* When oats are sown upon clover crop, the seed is sometimes sown without pressing, but the practice is not quite satisfactory.

WHEAT SOWING.

Wheat sowing may be done by broadcasting on a pressed furrow, or drilling on a harrowed surface, from September to April, if the right descriptions of wheat are chosen. There is a bearded variety called April wheat, which allows of the latest sowing. Good winter wheats may be sown from September to December; and spring wheats may always be sown from January to March.

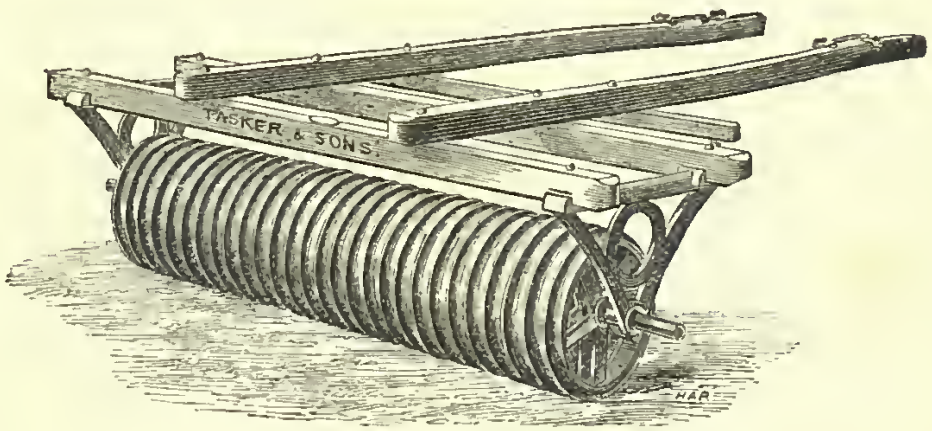


Fig. 27.—CAMBRIDGE ROLLER.

Quantity of Seed.—Much has been written upon the quantity of seed, some people believing in thin and others in thick seeding.

All depends upon the nature of the ground and the time of year. *On good land and early in the season the smallest quantities of seed may be used—i.e.*, about six pecks or one and a half bushel per acre. *On poor land and late in the season, the largest amounts of seed are required—i.e.*, from

twelve to sixteen pecks, or from three to four bushels per acre. Anything less than six pecks per acre must be looked upon as exceptional, and as only suited for special cases.

"Pickling" Wheat Seed.—Dressing or pickling wheat is necessary to prevent the attacks of certain very minute *fungi*, which cause what is called smut, bunt, slain corn, or black ears. Most of us have noticed these black ears, when, instead of a healthy well-formed head, there is a powdery black mass, that is finally scattered with the wind or beaten off by the rain. It has been found that this disease can be prevented by dressing the seed with certain solutions. A strong brine has been used, and so have other substances, but the best appears to be one to two pounds sulphate of copper (copperas) dissolved in two gallons of water for each quarter of wheat. The dressing is poured over the wheat the day before sowing, and is well mixed with the whole mass by turning over several times with a shovel.

The water soon dries, or is absorbed by the dry wheat, and the copperas is left coating every grain. This kills the germs or spores of the fungus, and prevents it from finding its way into the young plant when it sprouts.

Manuring the Wheat Crop.

Good farmyard manure is one of the best applications for wheat. It is a well-known fact that when decaying animal or vegetable matter is spread over a field and ploughed in, it gradually mixes or becomes incorporated or blended with the soil. This is the case with farmyard manure. It gradually decays away,

and as it does so it is not lost, but becomes a part of the soil. Every child should understand that nothing is lost in nature. A burning candle, it is true, disappears, but the carbon and hydrogen of which it is composed are not lost: they are changed into carbonic acid and water, and float about in the air. If we set fire to a heap of straw, it blazes and the straw is burnt, but some of the elements which made the straw are still in the air, although changed into smoke and gas, while another portion remains on the ground as a small heap of ashes. Now, what takes place quickly when we set fire to straw, takes place much more slowly when farmyard manure is buried in the soil by the plough. It is not burnt, but it is slowly "consumed." It turns black, it loses weight, and it disappears, but the elements which made it are all retained or held in the soil.* Farmyard manure is partly formed of straw, so the *elements* or the **constituent parts** of straw are added to the soil. Good farmyard manure also contains the elements or **constituent parts** of corn, so that the elements or materials for making corn are also added to the soil. Farmyard manure is called a **general** manure, because it contains so many things that are wanted, and we may almost say everything that is wanted. The consequence is that when it is added to the land, it is enriched in everything that is wanted by a wheat crop.

Guano is the dung of sea-fowls, and is therefore in some respects like farmyard manure—*i.e.*, it contains the

* While in actual burning, the combustible parts of the straw are lost in the air; these same parts are only partially lost when slow combustion or decay takes place in the soil. The great mass of the organic (combustible) matter is then converted into that black or brown vegetable matter which is found in abundance in all rich soils.

remains of food, and the elements of food. When guano is put on a field it too becomes mixed with the soil, and the roots of plants find nourishment from its decay. Guano is a very good manure for wheat, and not only for wheat but for all sorts of crops.

Rape-cake and Oil-cakes are capital manures for wheat and other crops. You will easily understand now that these cakes will be useful whether scattered over the soil and ploughed in, or eaten by animals and then applied in the form of dung. In both cases the elements of plant food find their way into the soil.

Wool refuse, shoddy, sea-weed, fish refuse, animal refuse of all kinds, such as **bones, blood, hair, etc.**, are all good manures for wheat and other crops, because, like farmyard manure, they contain the *elements* of plant food, and when ploughed into the land they dissolve away and make the soil rich.

The same elements are also found in nitrate of soda, which contains a great deal of **nitrogen**; in superphosphate of lime, which contains **phosphorus**, sulphur, and lime; in sulphate of ammonia, which contains sulphur and **nitrogen**; in soot, which contains sulphur and **nitrogen**; in heaps of dead weeds and dead leaves, which also, like farmyard dung, are rich in plant food; also in rich soil from the bottoms of ditches and ponds, where vegetable matter has collected for many years. All these things are good for wheat, simply because they decompose, in some cases quickly and in some cases slowly, and add to the stock of plant food in the soil.

Perhaps the best way to obtain a heavy crop of wheat is to apply a good dressing of dung at the rate of about

twelve or fifteen tons an acre before sowing the wheat, and in the spring of the year, when the wheat is a few inches high, to top-dress (or scatter over the ground) about one and a half to two hundredweights of nitrate of soda, very carefully and equally.

It is wonderful to see how quickly nitrate of soda tells upon young wheat. In three or four days, especially if the weather is showery, the colour of the growing corn becomes of a darker green. The leaves become broader and higher, and the plants grow with great rapidity. Nitrate of soda is apt to wash through the soil; and it is for this reason that it should be put on the land in spring, when the roots are active, and the heavy rains of winter are over. Nitrate of soda should never be applied in the autumn or winter.

AFTER-CULTIVATION OF WHEAT.

Hoeing.—In March or April when the ground becomes dry, bands of labourers are to be seen hoeing the wheat with narrow hoes made for the purpose.

Or horse-hoes (Fig. 23, page 102) are used, which do the work cheaper and more quickly, but scarcely so well as is done by hand. Hoeing can only be performed when wheat is *drilled* in rows, and cannot be done when it is broadcasted, or sown all over the surface. This is one of the best reasons which can be given for drilling corn, and the drill and the horse-hoe are made for each other. When corn is drilled it ought to be hoed, whether by horse or hand. Hoeing has two advantages: it kills the weeds and it makes the surface of the ground loose and fine. It is wonderful to see how quickly wheat improves after it has been hoed.

Harrowing.—When labour is scarce and dear, farmers often use the harrow instead of the hoe, and it has a very similar effect. It loosens and moves the soil, and destroys a great many weeds. Wheat is so strongly rooted that the harrow does not hurt it, even if used twice or thrice over the same space. We have heard good farmers say that they can scarcely over-harrow their wheat, as, even if it is partly covered over with soil, it soon recovers, and seems much the better for its rough treatment. The treading of the horses also makes the young plants root better in the soil, *if the work is done in dry weather.*

Rolling.—On exactly the same principle, wheat should be well rolled in the spring as soon as the soil is dry. Rolling and harrowing are best done together, the harrow going first, and the roller following behind.

In the winter the ground becomes "hollow" with the frost, and the roots cease to be in close contact with the soil, but this is quickly set right by the harrow and roller and the treading of the horses. The wireworm (page 83) is also very liable to injure wheat until the ground is heavily rolled with an iron roller such as is shown in Fig. 27, page 115.

When wheat looks yellow and poor after winter, it can often be brought round by harrowing and rolling; and at the same time applying one and a half or two hundredweights of nitrate of soda. After these spring cultivations, or "tillages," have been given, nothing else is needed to be done.

Wheat grows rapidly as soon as warm weather sets in. If it looks thin on the ground and yellow in May (May-

siek) it alters rapidly in June, and then we say "a warm June puts all in tune." And again:

> The farmer went to his wheat in May,
> And came saddened and silent away.
> The farmer went to his wheat in June,
> And came away singing a merry tune.

Wheat needs heat, and a good wheat erop is always found to follow a hot and rather dry summer. A severe winter does not hurt it, but a hot June, July, and August are neeessary to properly mature it and fill the ears. Cold nights bring blight and badly-filled heads, so that, in spite of all we ean do, the sueeess of the erop depends upon the season. The farmer is very dependent upon the seasons and upon a blessing upon his labours; and this is always reeognised by good men, who remember that although "Paul may plant and Apollos may water, God alone can give the increase."

Nothing now remains but to keep the gate shut and the fenees in good order, and to wait for harvest. Wheat eomes into ear early in June in the south, and late in June in the north, and we reckon six weeks to elapse between this event and harvest. As soon as the ear is well out of the sheath, the blooming or flowering takes place. Little white bodies show themselves hanging to the ears, and if they are examined they will be found to be eomposed of the "anthers" which earry the fertilising pollen dust, suspended to fine filaments or threads whieh eonneet them with the inside of the flowers (florets). Wheat is fertilised or made to produee seed like other flowers by the pollen dust falling upon the pistil, and this is followed by the swelling of the grain.

The subject is rather difficult to explain, and ought to be studied separately by reading a good text-book upon botany. Agriculturists require a knowledge of chemistry and botany, and if agriculture is to be properly understood we must study not only these, but other sciences. Of late years many new sorts of wheat have been produced by placing the pollen dust of one sort upon the pistils of another sort, and thus producing wheats which resemble both parent forms, or what are known as crossed wheats.

It is very important that the weather should be warm, and calm during the blooming period, in order that the wheat may "set."

It is the same in growing fruit, as the gardener dreads frost, or tempestuous weather, when his wall fruit or orchards are in bloom.

The Wheat Midge.—It is at this time that a small gnat called the Wheat Midge does a great deal of harm by laying its eggs inside the chaff, just where the wheat grain is beginning to form. These little flies are hardly more than an eighth of an inch long in the body, and have long legs and horns (Ormerod). The eggs produce little red or orange-coloured grubs, very commonly seen inside the wheat chaff. They do a great deal of harm, and would do a great deal more if they were not kept down by the attacks of one of those ichneumon flies, already mentioned (page 94), which lay their eggs in the bodies of the grubs of the wheat midge.

WHEAT HARVEST.

When to cut Wheat.—Wheat is better cut before it is quite ripe, as it matures in the shock. The right time

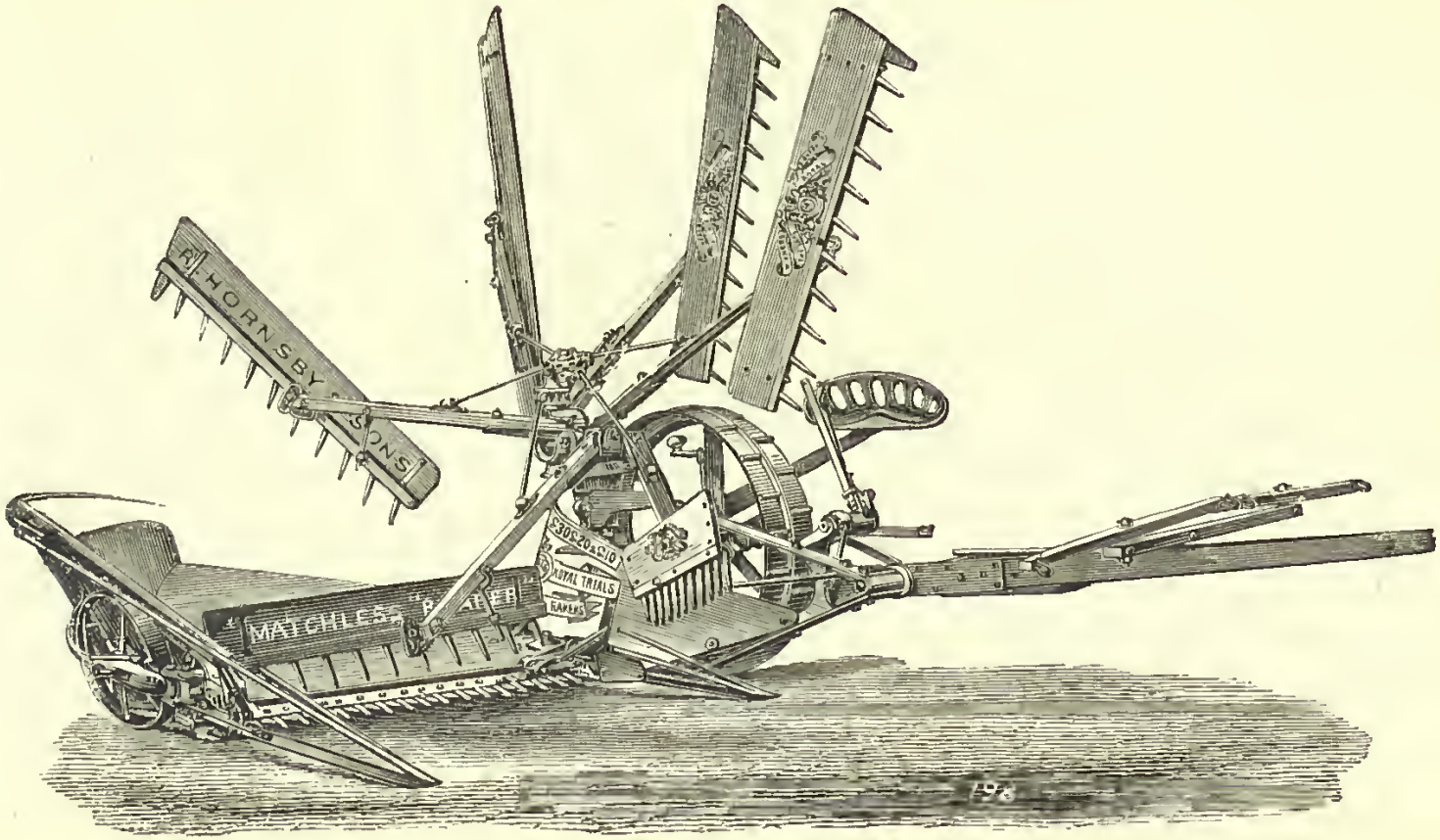


Fig. 28.—HORNSBY'S MATCHLESS SIDE DELIVERY.

to cut it is as soon as the grain is about as hard as newly-made or fresh cheese, and when it has ceased to be filled with a milky juice. The straw is often still rather green, and it is not a good plan to wait until the grain is hard, and the straw completely yellow.

Many good farmers cut wheat when you would scarcely

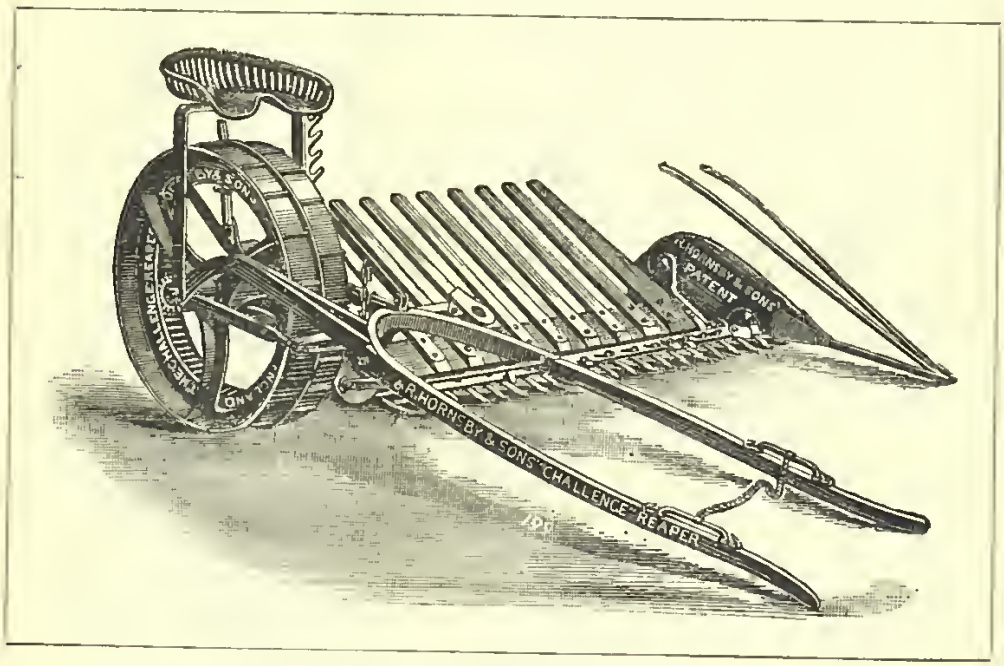


Fig. 29.—HORNSBY'S ONE-HORSE BACK DELIVERY REAPER.

think it ripe, and they say that it is better cut green. This is, however, a point for a great deal of judgment, as, if cut too soon, the grain becomes shrivelled and small. On the other hand, if allowed to stand too long, there is danger of losing the grain by shedding, especially if there should be a high wind. The straw is also better for fodder if it is cut rather before it is quite yellow.

The miller is also to be considered, as the price he offers for wheat depends upon what he thinks of the sample. If cut rather early, the grain is not covered with such a thick brown or outer skin, and looks clear, like horn; and this is what millers like to see. When the skin (bran) is thick, they say it looks "weak," and when the skin is thin they say it looks "strong."

How to cut Wheat.—The old-fashioned sickle is not now often used, but a great deal is still cut with the scythe. Reaping machines are now generally used, and furnish a rapid and cheap means of securing a crop. The best forms of reaping machines are shown on pages 123 and 124; they are called side delivery (Fig. 28) and back delivery (Fig 29) machines, according as the sheaf is delivered at the side or behind the machine.

In all reaping machines the same general principle of cutting is pursued, and the differences are chiefly to be seen in the methods of delivering the corn.

The Self-binders, or Harvesters (Fig. 30), are more useful in our colonies than at home, as our English crops are not only too heavy for these implements to cut and tie up, but are often so twisted and laid that it is impossible to use self-binders. Another reason why these implements are not much used in this country is that our corn is frequently sown with clover, which is growing under the corn at harvest time, and it would not do to tie up wet green clover in the sheaves. Grass or weeds are liable to cause corn to heat in the stack, if tied up in the sheaves too quickly.

When to cart Wheat.—If it is intended to thresh wheat in the field without making it into a rick, the grain

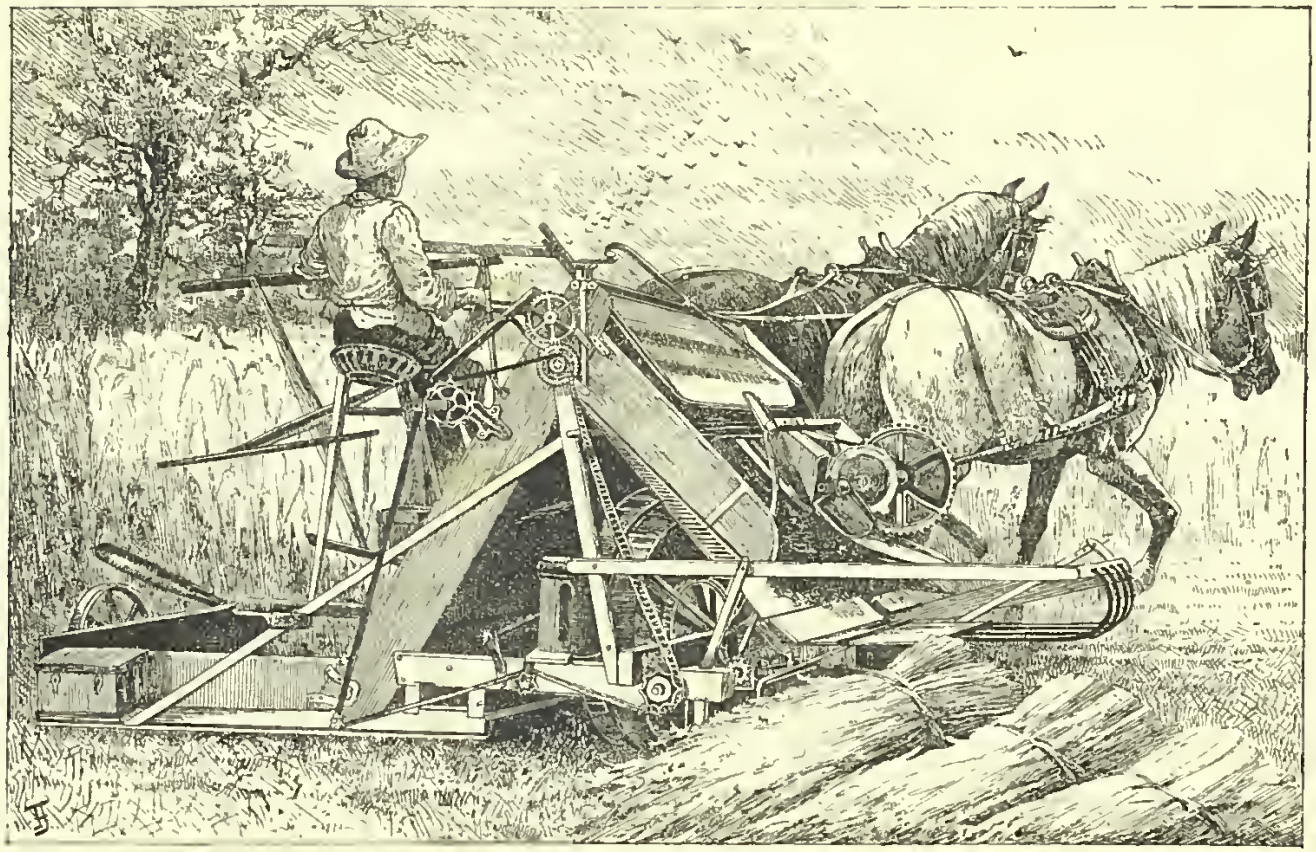


Fig. 30.—HARVESTER.

must be both hard and dry. It must be quite brittle, or bite off sharply and crisply when placed between the teeth. If, however, it is intended to make a rick, and to keep it for some time, it may be put together before it is quite so dry as this. Old wheat-ricks which have been kept for a year always thresh out dry and heavy, whereas new wheat is too often soft or out of condition. A great deal then must depend upon the length of time which the rick is meant to stand, but in all cases the straw must be thoroughly dry, the green herbage, whether clover or weeds, well pined, and the grain fairly hard.

Building Ricks.—Ricks are built either as long ekes or round staeks. The size of ricks must depend a good deal upon the condition of the grain. When thoroughly dry, and in good "order," it may be put into large ricks, and we may almost say the larger the better, as there is less exposure, less tops and bottoms, and outsides, in large ricks than in small ones. Large ricks are more common in the southern counties, and small ones containing about ten quarters of wheat each are very usual in the north. If ricks are built of a size to take up one good day in threshing them, it is found convenient, as no one likes to leave a rick open, or unfinished, after the thatch has once been stripped off.

Ricks should be carefully built, and should not be made in a slovenly manner. Badly-built ricks let the rain in, and the grain becomes damaged. A well-made rick should increase in size as it rises off the ground, and the sides should not be bulged out as they are often seen to be; the eaves slightly overhang the sides, so as to throw the drip clear away from the stack bottom, and the

top forms a well-shaped cone, in round ricks, or a prism-shaped covering in long ricks. During the building of a rick, if the middle is always kept full, or rather higher than the outsides, the sides will be slightly pushed out, and grow out as it rises in height. If this plan is followed the butt end of the sheaves will incline downwards towards the outsides of the rick, and thus water will always drip off the ends of the straws without penetrating the rick.

Boys should watch how ricks are built. The best way to learn to build them is to hand the sheaves to the rick-maker, and thus help him. After a while a boy may be allowed to lay some of the inside sheaves, and when he can do this well he will be allowed to lay the outside sheaves, which is more difficult. Some men take a great pride in their ricks, and finish them off with great care. When neatly thatched, and trimmed round with a sharp knife (shaved), a row of well-made ricks looks very well.

Stacking in the Field.—The plan of stacking corn close to where it grew has been introduced since the invention of the portable threshing machine.

In the older days the corn was always brought home to the rick-yard, because the threshing machine was a fixture. Now the rick is put down anywhere that is convenient, and the portable machine is drawn up by its side, and it is threshed in the field. By this method the straw is left where it can be made into manure, while the corn is carted home. It is a very common sight to see cattle, pigs, or even sheep, in field-yards made with posts, rails, and hurdles, eating and treading down the straw left after threshing, and making it into manure.

The full benefit of this plan of stacking is found in saving labour and expense both at harvest and in earting the manure back from a long distance.

Field barns are useful on long or wide lying farms, chiefly beeause they save carting and travelling long distances, and they are used in combination with the system of stacking corn in the field, and threshing with portable machines.

PREPARING WHEAT FOR MARKET.

Threshing.—The oldest and simplest plans of threshing corn, or separating the eorn from the straw, consisted in beating with a flail, or jointed stick, the two parts being united by a leather thong. The workman grasped the longer part with both hands, and whirling the other portion around his head, brought it down with suceessive thumps upon the corn spread out on the threshing floor.

Horses and bullocks were also employed to tread out the corn, and both of these methods are frequently alluded to in the Bible. Thus the threshing floor is often spoken of, and we are told not to "muzzle the mouth of the ox that treadeth out the eorn."

Threshing machines (Fig. 31) are now in general use, and very little corn is threshed by flails. The threshing machine was invented by Andrew Meikle in the later years of the last century, and came into general use at the beginning of the present century. There was much opposition to its introduction, as it was feared that it would take the work of the labourer from him in the winter. Such has, however, proved to be a false alarm, and there is still plenty of work for those who want it. In one of the fields on the

writer's own farm the threshing machine was broken up and burnt by an angry mob many years ago.

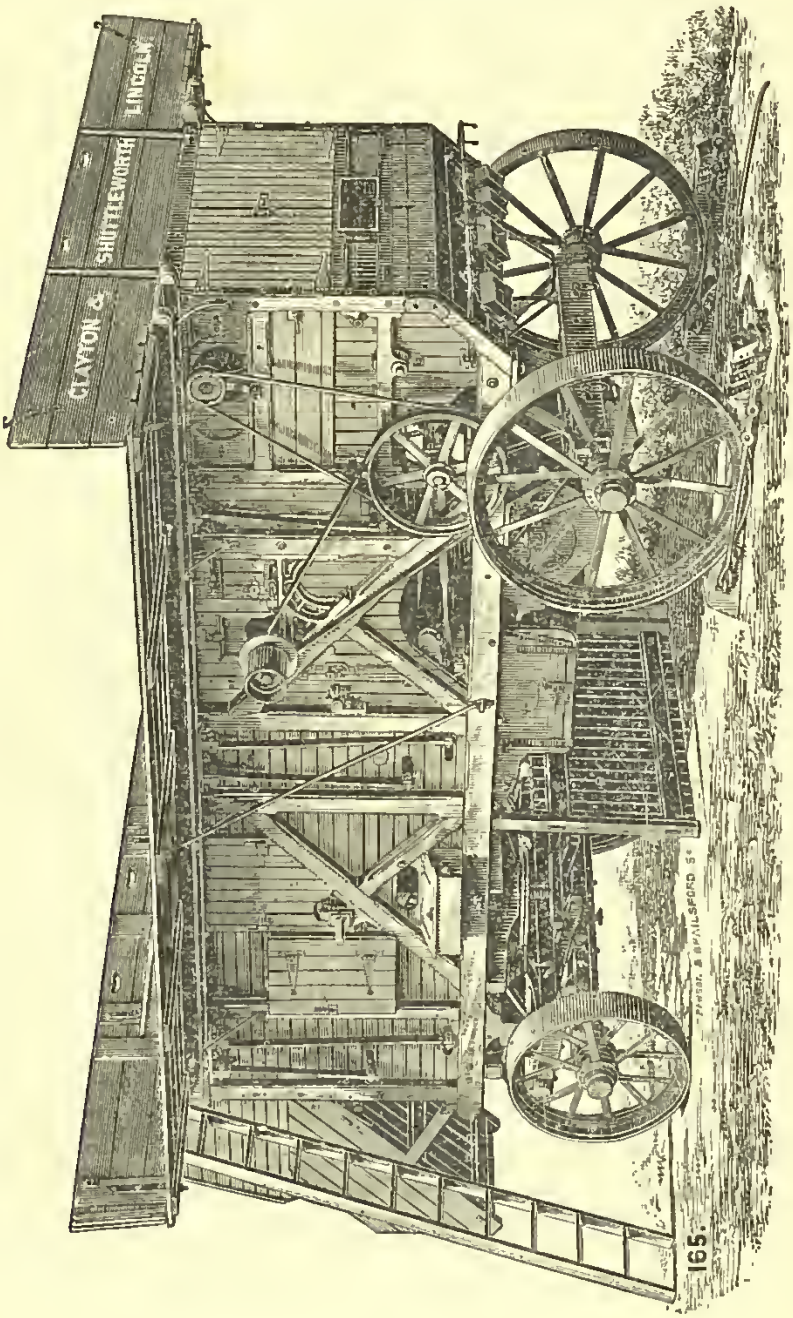


Fig. 31.—THRESHING MACHINE.

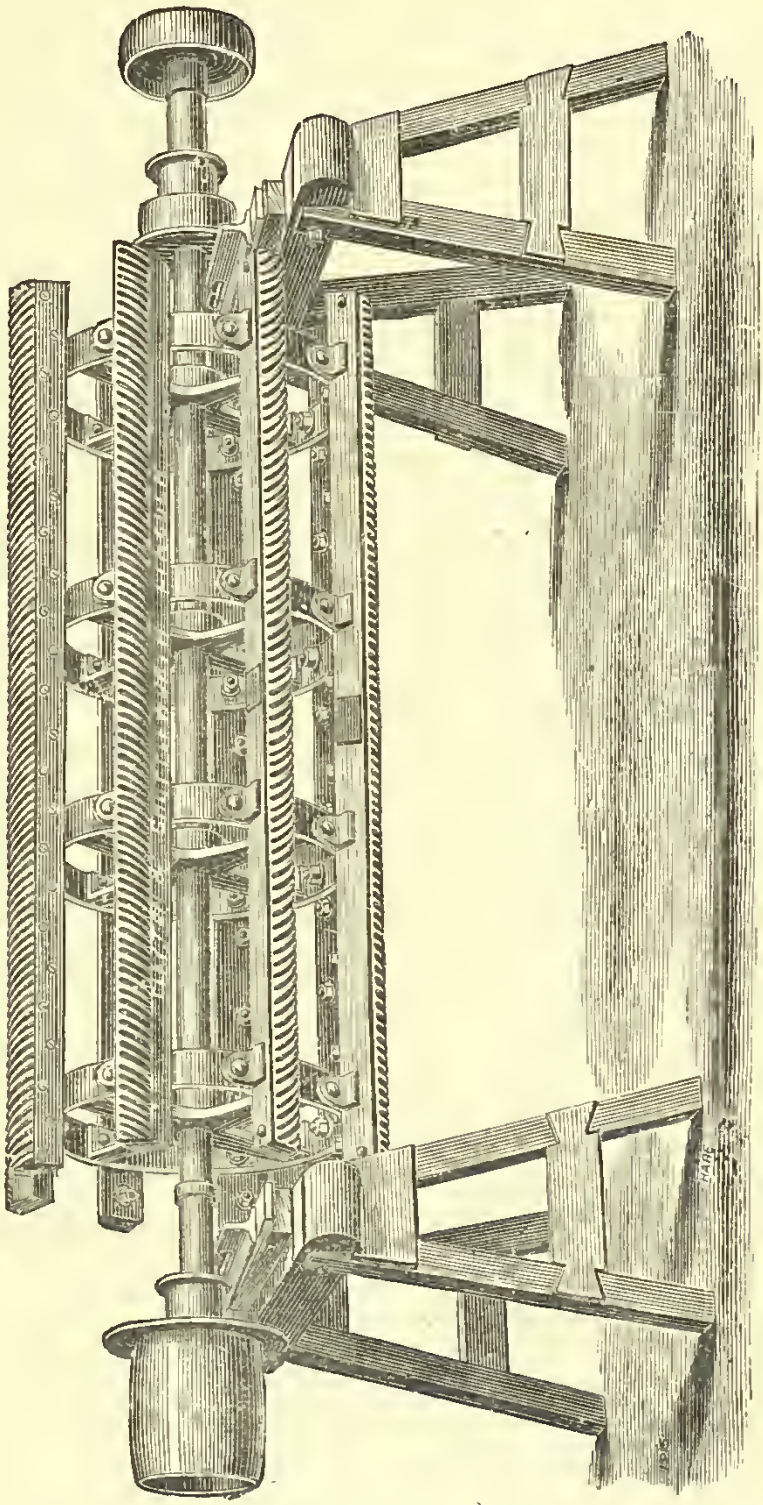


Fig. 32.—DRUM AND BEATERS.

Threshing by steam is almost as simple as threshing by hand. The work is performed by a revolving drum carrying fixed beaters, which pass very closely to a concave placed close to the drum.

The drum is worked by a belt from an engine, and made to turn round 800 to 1,000 times in a minute. As there are six or eight beaters, each one must turn round as many times as the drum, and thus a beater strikes the corn from 4,800 to 8,000 times in a minute.

This completely separates the corn from the straw, and thus takes the place of the old flail. Fig. 32 shows a drum and concave, and will help to explain how the work is done.

Combined threshing machines.—Although the work of threshing is really very simple, a combined threshing-machine is a complicated affair.

Not only is it expected to thresh with great speed, but also to winnow, screen, polish, remove white coats, hummel barley, deliver into sacks, and weigh up the corn fit for market. These machines cost about £120 to £150 each, and the engine which drives them costs about £220, so that a great deal of money is required to purchase them. They cannot be dispensed with on large farms, and costly though they are, they do the work required of them much cheaper than it could be done by hand.

Winnowing.—Until recent times winnowing was done by taking advantage of the natural wind, the corn being thrown up with a shovel to meet the breeze. The writer possessed an old-fashioned winnower, which consisted of a frame-work carrying loose cloth sails, which as the frame was turned round caused a wind, against which the corn was thrown up by a shovel. This primitive machine was

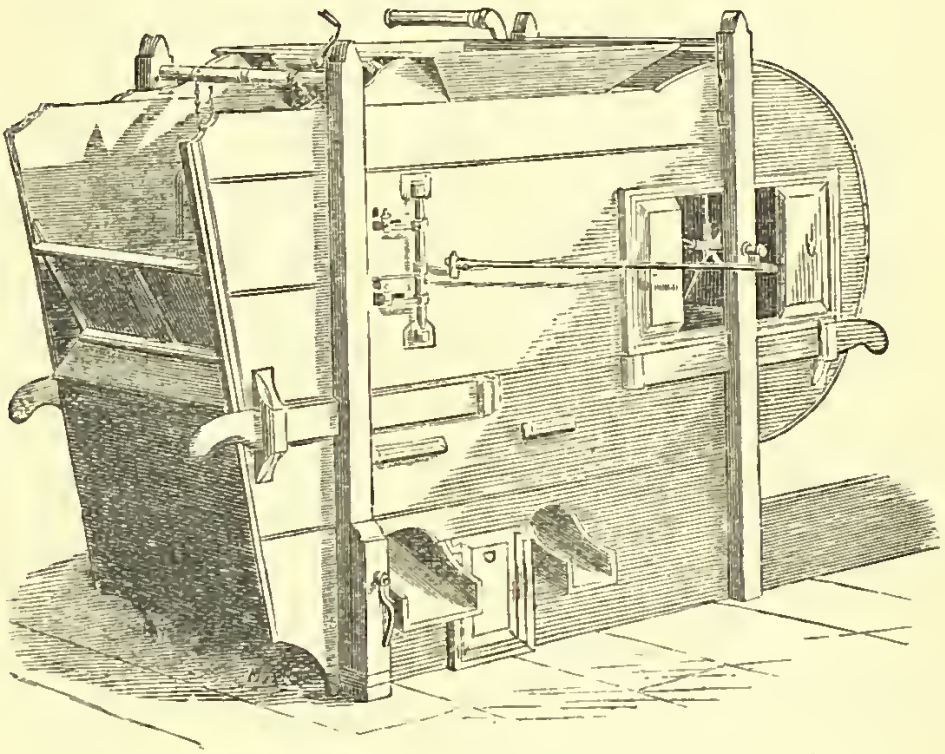


Fig. 33.—A WINNOWING MACHINE.

in constant use forty or fifty years ago, but has been entirely superseded by the modern winnower (Fig. 33).

In these implements the wind is raised by means of revolving fans, and the corn is winnowed as it falls from the hopper on to the riddles.

In these machines five separations are made—that is, the corn put into the machine comes out in five portions: 1, dressed corn; 2, light corn; 3, thin corn; 4, seeds of weeds and small dust; 5, chaff. What is called a Blower is simpler than a winnowing machine, and consists of fans and riddles held together in a suitable framework of wood.

Yield of Wheat.—The average yield of wheat in Great Britain is estimated to be twenty-eight and a half to

twenty-nine bushels per acre. This is taking all kinds of land, rich and poor, heavy and light, all over the country, and it does not give a correct idea as to what is produced on well-farmed lands. The heaviest crops of wheat will give sixty bushels per acre, and in some cases even more have been grown. On ordinary well-farmed land thirty, thirty-two, or thirty-six bushels per acre would be considered to be fair crops, and forty bushels per acre is always looked upon as a good crop of wheat. The weight of a bushel of wheat will usually be from sixty to sixty-two pounds, and when very dry it may weigh as much as sixty-eight pounds. Damp wheat will only weigh fifty-eight or fifty-nine pounds per bushel.

BARLEY.

Much of what has been already said with reference to the general rules of wheat cultivation is also true of barley. In giving a short account of barley cultivation, we shall therefore take those points in which the management of this cereal differs from that of wheat. First, then, it is of importance to know that the climate of Great Britain is, on the whole, better adapted for barley than for wheat. The moderate heat of an English summer, the somewhat moist air, and considerable rainfall, favour the production of a mellow description of barley, well suited for malting. Good English barley commands a better price than the hard thin barley which is imported from foreign countries, and, as a consequence, the price of barley has not fallen so much as that of wheat. Good barley still sells at forty or fifty shillings per quarter, whereas wheat of the best quality only makes about thirty

shillings, and yet, as a rule, more barley than wheat can be grown per acre.

On the other hand, barley is more apt to be injured in quality by the way it is treated, and by changes in the weather, and when it has suffered from either of these causes it is seriously lowered in value. The great object of the barley-grower is to produce a good malting sample, and if the sample produced is not fit for this purpose, it is generally used for pig-feeding or for distilling, and will not bring more than twenty-two or twenty-four shillings per quarter.

There are **three species of barley**: six-rowed or winter barley, grown entirely as a fodder crop, and eaten on the ground by sheep when it is only a few inches high; four-rowed barley, which is also known as Bere, and is a coarse and hardy sort, grown chiefly in severer climates than our own—it is cultivated to some extent in the North of Scotland; two-rowed or summer barley, which includes all the finer descriptions of malting barley. Among the principal of these is Chevalier, Golden Melon, Peerless White, Minting, Cheyne, Thanet, etc. The differences between the various sorts of barley are not so distinct as between the varieties of wheat, and lie principally in the degree of fineness, colour, and quality of each kind

Place in Rotation.—Barley is the second crop in the Norfolk rotation, and therefore follows "roots." It is important that the land should not be too highly manured, as the crop will then become laid, or fall flat on the ground. When this happens the grain cannot mature properly, and the result is a large crop of thin or lean corn, which is not fit for malting. Some of the best samples of malting barley are grown after wheat under the system

known as the Wiltshire rotation (page 21). As already mentioned, wheat requires land to be in high condition, and it is better than barley for extra rich land upon which sheep have fed off a heavy crop of roots, with additions of cake, corn, and hay. Such land will often be found capable of growing a good and high quality crop of barley after the wheat..

Rules for growing a good Quality of Barley.—If it is wished to grow a really good quality of barley, great care is required in a number of ways. The land must be of a rather light and naturally dry character. (1) Somewhat thin chalky soils, light sandy loams, or "brashy" limestone soils, abounding in stones, are all suitable for this crop. As a rule, sheep land is well suited for barley, and hence farmers speak of "sheep and barley land," or of turnip and barley land. (2) The soil must be worked into a very fine state of tilth, and any roughness or cloddiness is sure to tell against both quantity and quality. (3) The seed should be sown as early as possible in the year. Some of the best samples have been grown after sowing in February, or even January, in favoured districts. Barley is mostly sown in March, and may be successfully sown in April or early May; but although this is often done, the fact remains that late sowing is risky. (4) Care should be taken to secure good seed, and of a good kind. (5) Barley should be drilled rather than broadcasted. (6) Two bushels is enough seed for one acre, but on thin, high-lying soils, three, and even four, bushels may sometimes be sown. (7) Barley should not be cut until completely ripe. The indications of ripeness given for wheat are not to be taken as correct for barley,

and this is chiefly owing to the different use to which barley is put. The test of ripeness in barley is its hardness, which should be such that it can resist pressure with the thumb nail, or break off short when bitten. The head also turns down, and the straw becomes white. When barley has arrived at this stage, it may be cut. (8) Great care is necessary in harvesting barley. It is usually raked up loose and put into the rick like hay, without being tied up in sheaves. In most northern districts, however, it is tied up like wheat. (9) Barley must be thoroughly dry, and in no danger of heating before it is carted into the rick. (10) Many samples are spoiled by mismanagement in threshing, and in winnowing and screening it before offering it for sale.

It will be seen from these ten rules that mistakes may be made at all stages of barley cultivation. A great deal more might have been said upon each of these rules, and if any one hopes to be of assistance to others, or to succeed himself in growing a good sample of barley, he will do well to pay attention to each of them.

Two operations are required for barley that are not needed for wheat. "Hummelling," or removing the awns or beard. This is done in all combined threshing machines by the rapid revolution of a number of short, blunt knives, arranged upon a spindle, running lengthways through a cylinder. The newly-threshed barley is carried up to this cylinder and passed through it. Here it is subject to the action of the knives, and when it comes out at the lower end the awns are gone. Hummelling is sometimes done with a separate machine, or by a hand instrument upon the barn floor, known as a barley stumper.

Screening is effected by passing the barley slowly over a series of iron rods placed so close together as only to allow the thin corn to pass through them. The plump, good-sized grains pass over the surface of the screen, and the sample is thus rendered more uniform and saleable. The thin barley may be ground up for live stock, or used as seed. The screenings from a good sample of barley are thought by many farmers to be quite as good for sowing as the larger and plumper seeds which pass over the screen, but there is room for a difference of opinion on this point. Fig. 34 shows a combined implement which at once removes the awns, blows out the dust, and screens barley.

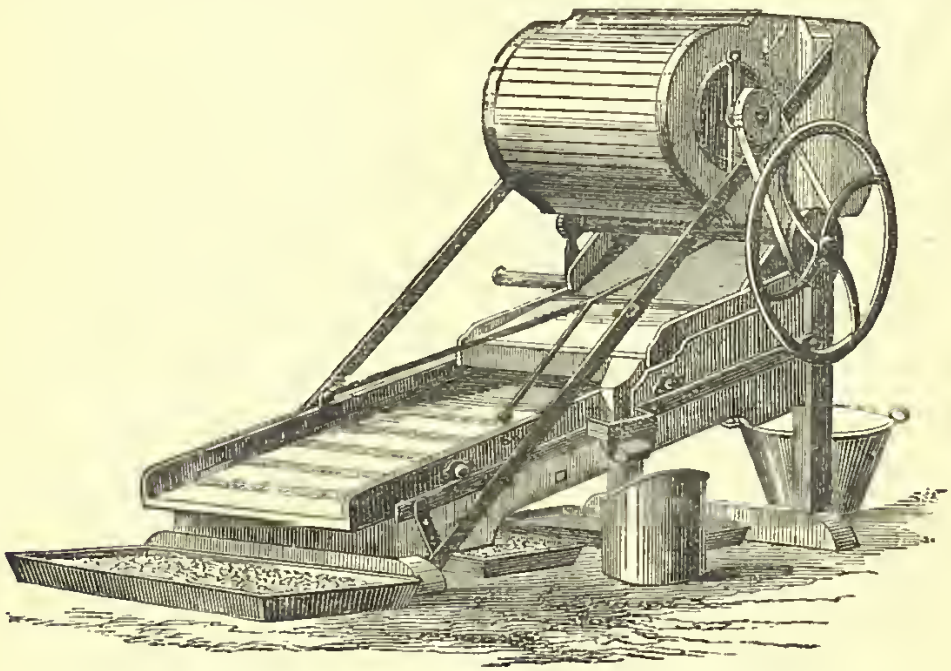


Fig. 34.—A BARLEY SCREEN AND HUMMELLER.

Barley differs from wheat in the fact that the chaff is adherent or attached to the grain. It is richer in starch

than wheat, and it is chiefly on this account that it is used for brewing.

Malting consists in wetting the barley and allowing the seed to germinate. After eight days the grain is sufficiently sprouted, and it is then placed in a kiln and dried, and the sprouts and small rootlets (coombs) are then removed by a mill. In the process of sprouting (germination) the starch becomes converted into malt sugar. The malt is then crushed and placed in a mash tub, where the sugar is extracted by means of water, and a sweet fluid or "wort" is the result. This sweet liquor, when fermented, is beer or ale.

Yield of Barley per Acre.—Barley is capable of producing rather heavier crops than wheat, partly because the chaff being firmly attached to the grain forms a part of the saleable corn. Forty bushels is a good crop of barley, and sixty bushels must be considered as a very good yield. The average yield of barley may be placed at about thirty-two bushels per acre.

OATS.

Oats constitute a very important crop, especially in Scotland, where oatmeal porridge is a favourite food. In England oatmeal is not so largely used, and it would be better if it were more largely employed as an article of human diet. It is nourishing and wholesome, and when eaten with milk it forms a very agreeable dish. The English working classes have, however, never taken to it in anything like the same manner as their Scotch neighbours.

Oats are the best horse corn which can be produced, and it is for this purpose that the crop is chiefly grown in England.

Oats, like wheat and barley, belong to the order of true grasses, and to the family *Avena*. There are two

species, the Tartary or Tartarian (*A. orientalis*, Fig. 36) and the common oat (*A. sativa*, Fig. 35).

Fig. 35.—COMMON OAT (*Avena Sativa*).

There is also the short oat (*A. brevis*) and the naked oat (*A. nuda*), but the leading British varieties belong to the first two species. Varieties of oats are almost endless, and many of them are of Scotch origin. Thus we have the Early Angus, Kildrummy, Barbachlaw, Mungoswells, Hopetoun, and Sandy. Among the heavier descriptions may be named the Poland Canadian and Potato, and there are also White and Black Tartarian, Waterloo, Dun or Winter, etc.

The cultivation of the oat is in many respects similar to that of the other cereals. In the northern counties it follows clover and grass seeds, and in the south it is more commonly grown after a root crop. With the exception of the Dun or Winter oat it is sown in early spring, in the same manner as barley. The cultivation of the two plants is so similar that after a field had been prepared for the one crop it might be sown with the other with every prospect of success. Oats, however, do better than barley upon stiff or peaty soils, and thrive upon rich soils on which barley would probably lodge (fall down flat). Oats have always been regarded as greedy feeders, and they yield a much greater number of bushels per acre than either of the other cereal crops. They have been known to yield over a hundred bushels, although eighty may be regarded as a first-rate crop. An ordinary crop of oats will yield from fifty to sixty bushels per acre.

Fig. 36.—TARTARIAN OAT (*A. Orientalis*).

The cultivation of the oat generally consists in ploughing, sowing, and harrowing. When taken after grass we should recommend—

Ploughing and pressing in January.
Broadcasting in March with three or four bushels of seed.
Harrowing repeatedly, and in two or three directions.

When taken after turnips the land would be ploughed, the oats sown, and the land well harrowed. Or the land may be ploughed, well harrowed, and drilled. Rolling finishes the operations.

Oat Harvest.—Oats must be cut early, as they are liable to blow out in heavy winds. Like wheat they are better cut before they are dead ripe, and allowed to mature in the stook.

One of the most valuable parts of an oat crop is the straw, which when well secured, that is without injury from rain, forms a very excellent food for all kinds of live stock. In this respect it is superior to both wheat and barley straw.

BEANS AND PEAS.

These plants have been already referred to as "black crops." Both are commonly cultivated, and as they ripen their grain and the produce is frequently sold off the farm, they rank as corn crops. Beans are suitable for clay soils, while peas suit lighter soils, and both are good preparations for white straw crops. Like all leguminous plants, beans and peas leave the surface soil rich in nitrogen, and as a consequence the bean is a good preparation for wheat, while peas are more suitable to precede barley. On some of the stiffest clays alternate crops of beans and wheat sometimes occupy the ground for many years in succession without exhausting it. In more ordinary cases beans as well as peas occupy the third place in the Norfolk four-years rotation, taking the place of clover (pages 21 and 23). The cultivation of both these crops is very similar to that of ordinary corn crops, and consists in

ploughing up the previous corn stubble, harrowing until the furrow is well broken, drilling, and harrowing. About two and a half bushels of seed is suffieient, because they are sown at wider intervals between the drill rows than the eereal erops.

Beans ought to be kept clean during the earlier period of their growth by means of both hand and horse hoes, and are therefore sown in rows about eighteen inehes apart. Hoeing is eontinued until flowering, after whieh it is no longer advisable to work among them. They are harvested either by means of the ordinary reaping maehiue or may be eut by a heavy bean hook, and are then tied up with short straw ropes and left to dry. On elay lands the beau may be used as a partial substitute for the root crops, as it may be so eultivated as to keep the land clean. If it is eaten upon the farm, either whole by sheep and horses, or as a bean meal for pigs and eows, it assists to keep up the fertility of the land. Bean straw is a valuable fodder for horses, and when passed through the ehaff eutter and moistened with water it forms an exeellent basis for feeding bulloeks.

Peas are not so well adapted for hoeing as beans, on aceount of their long and straggling straw, whieh eovers the ground, and stretehes out to a great length. Pea straw is frequently seven or eight feet long, and as it is recumbent, or lies elose to the ground, it soon stops the hoes, whether handled by men or drawn by horses. Peas are cut by siekles or hooks, and thrown into heaps or "wads," which are then frequently turned, and when dry they are carted to the rick. Peas should also be consumed at home, and form a eapital food for sheep and lambs,

either when given whole or cracked in a mill. Pea meal has about the same feeding value as bean meal, and is well adapted for young stock, as it is a flesh-forming food. Pea straw, when well-harvested, is a good fodder for sheep, and is in high favour for this purpose in the north of England.

CHAPTER IX.

GRASS CROPS.

Seeds.

THE term "seeds" is usually understood to mean the crop which occupies land in the third year of the Norfolk rotation :—

Roots—Barley—*Seeds*—Wheat.

They come after barley and before wheat, and they differ from all the other crops in being sown upon the land when another crop is growing. The "seeds" are sown upon young barley, and sometimes upon oats, or even upon wheat, should these crops have taken the place usually occupied by barley. The land has already been ploughed and harrowed for the corn crop, and is in a well-worked

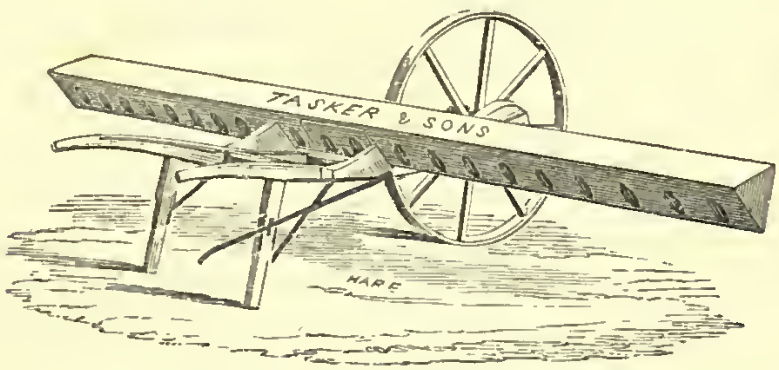


Fig. 37.—SEED BARROW.

state. The barley too has been sown, and may be about two or three inches high when the small seeds are sown upon it by means of the broadcast barrow shown in Fig. 37.

These barrows are wheeled over the ground by a man, and as they are of considerable length they cover a large area of land in the day. They are V-shaped across and perforated with holes at intervals to allow the seeds to fall out, each hole being guarded by a brass plate which regulates the feed. A long spindle, carrying brushes at intervals exactly opposite the holes, pushes the seed out, which then falls to the ground (Fig. 38).

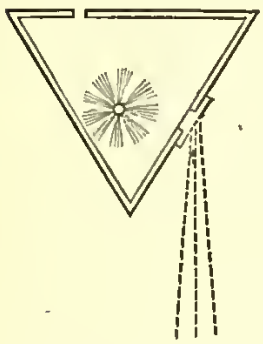


Fig. 38.—SECTION OF SEED BARROW.

Two barrows should be used, the one containing the grass seeds, and the other the clover seeds.

After the seed has been sown, the land is gently worked with a light one-horse harrow, and rolled, and this completes the work. The seeds grow under the barley crop, and when it is removed from the field at harvest the clovers and grass seeds are left in possession of the ground. This is a simple and inexpensive cultivation, but is quite sufficient for these seeds, as they love a fine and shallow seed bed.

Mixtures of Seeds.

The most important matter is the proper selection of the seeds which form the mixture used, and a few remarks are needed to make this point perfectly clear. The mixtures employed are simple, but depend a great deal upon the length of time that the seeds are intended to lie. Thus mixtures for one year's mowing and grazing are the simplest, and mixtures for two, three, or four years are more complicated.

Mixtures for one Year.—Taking the simplest first, we find that

14 lbs. of red clover, and
1 bushel of Italian rye-grass

are sufficient seed to yield a heavy crop of hay, and grazing afterwards. As, however, red clover is uncertain because of "clover sickness," it is better to reduce the quantity of this seed and to add two or three other kinds of clover in its place, as follows :—

	lbs.	lbs.
Red clover	8 or	10
Alsike clover	2	
Yellow clover	4	
Italian rye-grass	1 bushel.	

Again, as some farmers object to Italian rye-grass, we might partly substitute for it some perennial rye-grass, and sow half perennial and half Italian rye-grass.

Mixtures for two or three Years.—When grass seeds are required to lie for two or three years, it is necessary to introduce white Dutch clover, and to still further lower the amount of red clover. Some other grasses may also be added to the rye grasses, giving the following mixture :—

	lbs.
Red clover	6
White Dutch clover	2
Alsike clover	2
Yellow clover	4
Perennial rye-grass	7
Timothy grass	2
Tall fescue grass	2
Cocksfoot grass	4
	29

Mixtures for three or more Years.—Such mixtures

almost approach to the nature of seeds for permanent pasture (*see* page 199), and become still more complicated. Red clover is not any longer suitable, and its place must be taken by the perennial or everlasting sort of red clover known as cow grass. The quantity of white Dutch may also be increased. This is a model for such a mixture :—

	lbs.
Cow grass	4
White Dutch clover	4
Alsike clover	2
Yellow clover	4
Sheep's parsley	1
Cocksfoot grass	4
Timothy grass	2
Foxtail grass	2
Tall fescue	2
Perennial rye-grass	8
	33

It will be noticed that a rather heavier seeding is required when it is intended to leave land down for the longer periods.

The Cultivation of Permanent Grass.

Grass is the natural produce of land. It covers the boundless prairies of North and South America, and wherever the cultivation of crops has not been attempted. If man ceases to cultivate the soil, Nature again steps in, and in a short time grass springs up and makes a pasture. Heaps of earth on the road sides soon become green with grass, and when a road is no longer used for traffic it changes into that beautiful object, a green lane. In many parts of England we can see that land, now in grass, was once ploughed and employed for corn growing, as is proved by the rounded ridges, which could only have been made by

the ploughman. In some cases this land has not been cultivated for hundreds of years; perhaps not since the time of the Romans. It is sometimes found in the condition of unenclosed commons, which have been grazed by the cattle and geese of cottagers and villagers for centuries, and yet there is the trace of its having once been under the plough.

When corn was dear a great deal of pasture land and downs were broken up or ploughed, so as to grow wheat, but now, when corn is cheap, there is a tendency to lay it down again to pasture.

Strange as it may seem it is not always easy to make a good pasture. Land, it is true, will always grow enough grass to make it look green, but that is not the same thing as a good and profitable pasture, or meadow. There is a great deal of poor grass land, and newly-made pastures are generally poor. Grass land requires time and good management, and also a good deal of money to be laid out upon it before it becomes rich, and hence it is of importance that we should know the best and cheapest way of making it. So much time and money is wanted that it has been said to be almost ruinous. Hence an old saying that—

"To make a pasture will break a man."

To understand the meaning of this old saying we must keep in mind another specially true saying, that "time is money." Now if a farmer has to wait a number of years before his pasture becomes good, it is evident that he is losing money every year that he has to wait.

It is possible that he may not see the fruits of his waiting and watching. His successor, or in some cases his

children, may reap the benefit of his long waiting, and hence we see that there is truth in the old proverb.

Land requires to be rich before it will grow plenty of good grass, and all old pastures, if they are of good quality are rich, or full of plant food. They become much more fertile than the arable land in the adjoining fields. They have had a long rest, and have been grazed with live stock which leave their dung upon the surface, and make them rich.

Why Pastures require Time.—The reason has already been partly given. It is, however, very important that we should follow out the history of a field which is being converted into old grass land. First, then, tillage or plough land is often poor. It cannot grow more than one crop of corn without being well manured.

It must then be in a somewhat poor state. I can best prove this by comparing it with a field which has been for a long period under grass. Such fields when they are ploughed up have been known to yield many splendid crops of wheat in succession, sometimes as many as fifty or sixty. Such newly-broken up grass land is evidently very rich. Many farmers would be only too glad to plough up their grass lands in order to grow crops and sell the produce. This fact has also been expressed by a proverb :—

"To break a pasture will make a man."

This is the reverse of the last saying quoted. The two proverbs show quite clearly that grass lands tend to become richer by a very slow process, but if they are afterwards ploughed they will give up their riches by a much quicker process. They may be compared to a tree which

stores up material year after year. To grow a tree takes a long time; to cut it down takes a very short time. To make a pasture also takes a long time, and to plough it up takes a very short time. A tenant might like to plough up a grass field so as to get the riches it contains into his own pocket. The owner of the field would, however, be very foolish to allow any such thing to be done.

It takes time to make a good pasture, because a slow change must take place in the nature of the soil. It has to be converted into **vegetable mould.** The soil of a good old pasture is soft and free from stones. If it is rubbed between the fingers it will be found free from grit, and greasy or unctuous to the touch. It will be observed to be almost black in colour. If it were analysed it would be found to be rich in **nitrogen** and in the mineral food of plants.

Vegetable mould has been produced in a great measure by an insignificant creature, namely, the common earth-worm. These are found in large numbers in all pastures, and work silently and constantly. If we walk out on a mild wet night with a lantern, we shall see the grass strewn with them, but unless we move about quietly and without treading heavily on the ground they will quickly withdraw into their holes. In the mornings we can see some of the work which these humble creatures are always doing in the form of worm "casts" or little spiral heaps of very fine earth. The worms live by taking exceedingly minute pieces of vegetable matter and mud into their mouths. These particles pass right through the worms, and, as they pass, the nourishing parts are absorbed for the creatures' sustenance.

They are expelled in the form of worm sprouts or easts, and these will be seen to be eovering every part of the surfaee of the ground. This work is performed by many thousands of earth-worms night after night and year after year. Fine partieles of soil are eonstantly being heaped over the surfaee, and the eonsequenee is that the stones sink or are eovered over. They are undermined and eovered up and gradually disappear, while there is a gradual thiekening of the layer of fine soil thrown up by the worms. In twenty years the layer is shallow, but in an old pasture of fifty or sixty years' duration it is several inches thiek.

The dead roots of the grasses assist in forming vegetable mould. Grasses die and leave their remains in the land; thus in an old pasture the soil is blaek with organie matter resulting from this eonstant inerease of grass roots. The droppings of animals further inerease it, and the result of all these eauses is that the soil of old pastures is very different in its nature from the soil of an arable field.

It has been reeently shown that the important fertilising substanee, nitrogen, slowly inereases in a pasture.

How to make Pasture.—The best pastures rest upon eool, moist, and rather retentive soils, whieh again lie upon eool and retentive subsoils. Gravelly soils make early pastures, but they are apt to burn in summer. It is a fortunate eireumstanee that many soils, whieh are expensive to eultivate as arable lands, are well suited for grazing purposes, and henee a large extent of the stiffer sorts of soils have, during reeent years, been put down to pasture. In order to explain how pastures are best made, it is neeessary first to mention eaeh of the prineipal points

which must be attended to, and we can then make a few remarks upon each point.

1st—The land ought to be suitable for growing grass.
2nd—The land must be in good condition or full of manure.
3rd—The land must be clean or free from weeds.
4th—The seed must be well selected.
5th—The seed must be properly sown.
6th—The young pasture must be properly managed.

Having already mentioned the sorts of soil most suitable for pastures, we can pass at once to the second point.

As good pasture land is always rich, it is only natural that rich land should take easier to grass than poor land. It is, therefore, a good plan to sow grass seeds immediately after a bare fallow, or after a root crop which has been eaten with sheep upon the land. It is the usual practice to take a corn crop in these circumstances, but many persons prefer to sow grass seeds at once, and this is called sowing "without a crop." Now, as a corn crop is worth £6 or £7 per acre, it is evident that sowing without it is rather an expensive way of going to work. For this reason tenant-farmers usually sow their grass seeds with a crop of corn, and landlords, who have a more permanent interest in the land—it being their own property—are more likely to sow their grass seeds without the corn crop. Land intended for sowing down to permanent pasture should be well dunged and limed, or roots should be fed upon it, so as to bring it into high condition.

The Land should be clean.—It is not advisable to sow land to grass in a foul condition, and, hence, the importance of fallowing, in order to destroy weeds and bring the land into a clean condition.

The Selection of the Seed.—This is of very great importance, and is a subject of some difficulty. There are many sorts of grasses, some of which are valuable, while others are worthless. The various kinds of grasses ought to be studied, and there is no better way of learning to know them than collecting and drying them between leaves of white blotting-paper. Although there are so many kinds of grasses, not more than fifteen or twenty are ordinarily introduced into mixtures. A good mixture must, however, contain several sorts of clover and plants of a similar character, which help to form a mixture.

CHAPTER X.

GRASSES.

The name of Grass is often given to the whole of the plants which grow in a meadow or pasture, and farmers, in speaking of grass land, mean any land the crop upon which may be either mown for hay or grazed by cattle. But anyone who walks through a meadow in early summer is bound to see that there are many different kinds of plants in the herbage. It would take a long time to describe each of these plants one by one, and much trouble may be saved by first arranging them in groups. Though more than one hundred sorts of plants may be found in most meadows, it is yet possible to place each of them in one of three groups or classes. These classes are (1) grass plants, (2) clover plants, and (3) all other plants. The first group includes the true grasses, such as cocksfoot, foxtail, rye-grass, Timothy grass, and dogstail. The second group comprises the purple-flowered, white-flowered, and yellow-flowered clovers, the yellow-flowered trefoil, and also sainfoin, and vetches or tares. The third group contains buttercups, dandelions, thistles, daisies, cuckoo flowers, docks, and sorrel, and, in short, all plants which are neither grasses nor clovers.

In order to understand the structure of grasses, you must pull up a grass plant by the root. First examine the root. You will see it is made up of a large number of coarse threads, which are called root-fibres. They serve to attach the plant firmly to the soil, and are at the same time the means whereby the plant takes up food from the soil. This fibrous root of the grass is very different in appearance from such a root as you see in the radish or carrot, which are called tap roots. All grasses have fibrous roots, and so likewise have wheat, barley, oats, rye, maize, and millet, which are merely grasses grown for their grain.

Next, look at the leaf. If you place the grass leaf beside a clover leaf or a buttercup leaf, you will be struck by the differences. The grass leaf is long, narrow, and strap-shaped, and comes to a point at its free end. If you hold it between your eye and the light, you will see a number of ribs lying side by side, and passing from one end of the leaf to the other. Follow the leaf downwards, and it will be found that its lower part embraces the stem, and is therefore called the leaf-sheath. In most kinds of grasses the leaf-sheath is split in front. Pull the leaf slightly away from the stem, and look at the place where the leaf joins its sheath; you will notice a thin whitish outgrowth, which is named the ligule, and your attention is called to it because in some cases its size and shape will aid you to distinguish one grass from another. In some kinds of grass the ligule is very long and pointed, whilst in other kinds it is so small that you can scarcely see it, and there are yet others in which it is intermediate in size.

The flowers of grasses are not easy to understand. Perhaps you will be surprised to learn that grasses have flowers. Yet you must have noticed the beautiful appearance of meadow grasses in the month of June, and what graceful growths arise from them. In some grasses these growths take the form of slender spreading branches; in others they are so much closed up as to resemble in shape the tail of a cat or a fox, and names have been given to them to denote this resemblance. These growths are made up of the flowers of the grasses, but the flowers themselves are grouped together in a way you should notice. Take, as a good example, some oats in ear (page 140). Notice that the ear is made up of a number of parts, called spikelets, or little spikes, all alike, and all borne upon delicate stalks. Pluck off one of these spikelets, and open it carefully. At the bottom of the spikelet are two large boat-shaped leaves, almost opposite each other. Press these down between the finger and the thumb, and then you will see two or more flowers—or florets, as they are more often called, on account of their small size. These greenish little flowers, or florets, are as useful to the oat-plant as are the large yellow flowers to the buttercup, or the still larger scarlet flowers of the poppy to the plants to which they belong. In most grasses the florets are much smaller than they are in the oat-plant. In the wheat-plant, however, the florets are large, but the spikelets have no stalks, so that the difference in appearance of an ear of oats and an ear of wheat is due to the fact that in the one the spikelets are stalked and in the other they are not. You will thus understand that the ear (or panicle, as it is also called) of a grass is made up of

spikelets, and that each spikelet encloses one or more florets.

You will now be prepared to learn that in a pasture or meadow there are many different kinds of grasses, some of which are valuable, and others are not. You should learn to know the more important of these grasses, and in the descriptions which are about to be given the grasses most easy to recognise are mentioned first. For every grass you become acquainted with you will have one the less to learn, and the thought of this should spur you in your work. The illustrations given in this book of the grasses in ear will help you very much.

As regards the names, grasses, like all natural plants, have what is termed a common or trivial name, and also a systematic or botanical name. The common name is different in every country, and varies even in different parts of the same country. But the systematic name, which is usually of Latin origin, though sometimes from the Greek, or even from the name of a person or a place, is the same all the world over, which is a great advantage. As seedsmen in their lists of farm seeds give both the common English name and the systematic name, the same plan is adopted here, the systematic name being given within brackets. The capital letter following the systematic name indicates the botanist who gave the name. Thus "L." stands for Linnæus, the famous Swedish botanist, who named so many plants; "Br." stands for Brown, and so on.

Rough Cocksfoot Grass (*Dactylis glomerata*, L.) is one that you will easily be able to find, after you have studied the illustration (Fig. 39), for there is in the British

Isles no other native grass likely to be mistaken for it. You will notice that the spikelets are crowded into thick clusters, and this was the reason the term "glomerata" was included in the systematic name. Besides this, all the spikelets are turned to one side, so that in this case it is easy to distinguish the front from the back of the ear. This grass is very harsh or rough to the touch, and it is a large coarse-growing plant. The leaves are well worth examination; they are broad, bluish-green, and the sheaths are white and flattened near the ground. If you will carefully examine this grass as it grows in the field, you will find that you will be able to recognise it by its leaves alone, even when it is not in flower, and this is a very useful power to possess. Cocksfoot is a valuable grass to the farmer, and it thrives better in the hayfield than in the pasture: that is, it is more suited to mowing than to grazing, though it is useful for the latter purpose, if grazed sufficiently young. On account of its coarse, vigorous growth it is apt to become hard, and even woody, and therefore of less value as food, unless it is cut in good time. When young, it is very sweet and juicy, and much liked by cattle, but its coarse leaf-sheath near

Fig. 39.—DACTYLIS GLOMERATA.

the ground prevents its making a good sward in a pasture.

Meadow Foxtail (*Alopecurus pratensis*, L.) is a grass that comes into flower early in the spring, and it can usually be found in ear in April or at the beginning of May. It is well-named foxtail (for which Alopecurus is the Greek word), for the ear (Fig. 40) looks very much like a round tail ending in a point, and if you take it between your finger and thumb, and draw it along from base to tip, you will find it soft and silky. Double the ear down at about the middle, and you will see that each spikelet has a very short stalk, and that the spikelets are thickly crowded along the stem. The silvery-grey colour of the ear is partly due to the silky hair or bristle, called an awn, which springs from the solitary flower within each spikelet. The leaves are soft, green, and juicy, and though foxtail is a tall grass, is less robust than cocksfoot. It is much prized by farmers, both in the hayfield and in the pasture, and as it begins to grow early in the season, cattle can graze upon it while other grasses are coming forward. Children sometimes gather the ears of foxtail and plait them together into a long row, which they then adorn with buttercups and daisies.

Fig. 40.—ALOPECURUS PRATENSIS.

There is another kind of foxtail which has a very bad

character, for it is nothing less than a farm pest. This is *Alopecurus agrestis*, L., or slender foxtail (Fig. 41). You will not find it in pastures or in good meadows, but you will have to look for it upon arable land, especially in corn-fields. It differs from meadow foxtail in having a thinner or more slender ear, about which there is a good deal of dark colour, and on this account slender is sometimes called Black Bent. Another name given to it is Hungerweed, because it steals from the land the plant-food which ought to go to the nourishment of the crop. I have seen a field of wheat nearly destroyed by the abundance of this pest. Black Bent is generally in ear in May or June, and if it is not removed from the land before it has done flowering, it is likely to scatter its seeds in the field, and so to prepare the way for

Fig 41.—ALOPECURUS AGRESTIS.

Fig. 42.—ALOPECURUS GENICULATUS.

further trouble. It is one of the very worst grasses we have, and you should keep a sharp look-out for it, as it is very easy to recognise.

One other foxtail grass must be mentioned, although you are hardly likely to find it except in what are called water-meadows or by the marshy sides of streams. This is the elegant little floating foxtail, *Alopecurus geniculatus* (Fig. 42). It is much smaller than the other two species, and the ear is a very pretty object, particularly when it becomes covered with an orange-brown dust (pollen) from the florets. Floating foxtail is not an upright grass in its growth, its stem being too weak to grow upwards, and it therefore grows along the ground. You will be able to recognise it by the sharp joints, or "knees," which give to the stem a zigzag appearance. The specific name, *geniculatus*, means kneed. Floating foxtail, though not an objectionable grass in the moist situations to which it is suited, has no agricultural value, and it never seems to occur in any considerable quantity.

Fig. 43.—PHLEUM PRATENSE.

Timothy Grass, or Meadow Catstail (*Phleum pratense*, L.), may seem to you to have a curious name. It is a native British grass, and its cultivation upon the farm

was begun about a century ago by a man named Timothy Hanson, and thus the grass came to be called Timothy grass, or simply Timothy, the older name of catstail being now not much used. *Phleum* is the old Greek name for the grass. At first sight the illustration (Fig. 43) might lead you to think that the ear of Timothy is very much like to foxtail. So it is in general shape, but if you will gather specimens of each, and place them side by side, you will at once see how much Timothy and foxtail differ from each other. The ear of Timothy is green, and not silvery-grey like that of foxtail. If with your finger and thumb you take hold of the lower end of the ear of Timothy and draw it through by means of the stalk, you will notice that the ear is rough, and not smooth, as is the ear of foxtail. Both the green colour and the roughness of the ear of Timothy are due to the absence of the long, fine, silky awns which are so very noticeable in the ear of foxtail. Another difference between Timothy and foxtail is the time at which they come into ear and flower. Foxtail is an early flowering grass, and may often be found in ear in April. Timothy seldom comes into ear before June, so that if you look about the meadows in the last week of May or first week of June, you will most likely find foxtail, and thus you will be able to get to know it well before the Timothy shows its ears. Both foxtail and Timothy have rather broad leaves, though not so broad as those of cocksfoot. It is fortunate that grasses do not all reach their full growth at the same time, and that as some kinds get past their prime there are other sorts coming on to take their place in the pasture, From what has been said, you will learn that early in the summer cattle may get plenty of foxtail leaves, but not

much Timothy, whereas, later on, the Timothy leaves will begin to take their place in the herbage and the foxtail leaves to become scarce. Timothy is a good feeding grass, and is therefore prized by farmers.

Dogstail Grass, or Crested Dogstail (*Cynosurus cristatus*, L.), is a grass it is easy to know (Fig. 44), for you will find in the fields no other grass that you would be likely to mistake for it. Yon will notice that the spikelets lie close np to the stem, and that they are all tnrned to one side. In addition, yon will see that the ear looks as if it had been notched all along. If you were to take a tooth-brush and cut notches amongst the bristles, yon wonld make it look something like the ear of dogstail. The name Cynosurus is from the Greek ; the first part means dog, and the second part means tail. Cristatus is a Latin word meaning crested. Dogstail is a smaller grass than either cocksfoot, foxtail, or Timothy ; its leaves are narrower and it produces less herbage. It is a very common grass in old park-land, especially iu deer parks, and it may easily be known, because its stalks, with their ears, remain standing all throngh the winter, forming what are called brown bents. Dogstail helps to form a close, even greensward, and hence its seeds are used with others for producing lawns. It comes into car later than foxtail and earlier than Timothy, so that the ears can usually be found during the first half of June. Though it is not a bulky grass, nor yct of high feeding valuc, still farmers regard it as one of the useful grasses, and its seed is very commonly sown. It can be found in most of the rich old feeding pastures of England, and amongst its other qualities, it possesses the property of helping to form what farmers call a good "sole" to the turf.

There is a grass that comes into ear early in the spring, even sooner than foxtail, and although its panicle has somewhat the shape of that of foxtail, it is looser and has a more untidy appearance than the latter. Its herbage is but scanty, but when the stalk of this grass is chewed it is found to possess a sweet, lavender-like flavour, which calls to mind the odour of new-mown hay. To this grass, indeed, is very largely due the pleasant odour that arises on a summer day from a freshly-cut hayfield, as the grass I am speaking about perfumes the air in the process of drying. On account of its fragrance, and of its flowering in the spring, this grass is called Sweet-scented Vernal Grass, or, simply, Sweet Vernal (Latin *ver*, the spring). It has rather a long systematic name, *Anthoxanthum odoratum*, L., the former word being built up from two Greek words, the first meaning *anthers*, and the second *yellow*, in allusion to the frequently yellow colour of the little cases (anthers) inside the floret which contain the pollen. Remember that sweet vernal (Fig. 45) is one of the earliest grasses you are likely to find in ear, and this will help you in your search for it. Though it never occurs in large quantities, it may be found in most meadows and pastures, whilst in

Fig. 44.—CYNOSURUS CRISTATUS.

woodlands it continues to flower far into the summer. On the sheep-grazed downs in the south of England it grows in association with another well-known grass, Sheep's Fescue. The leaves of sweet vernal are flat and somewhat hairy, and the plant is never of coarse growth. Farmers regard it as one of the useful grasses, and it is prized for the odour it imparts to hay. Do you know a wild plant called woodruff? It is a small upright plant, with slender leaves arranged in a ring, and it is crowned with a number of small white flowers. It grows in woods, and when drying gives out the same delightful odour as sweet vernal. Country people often gather bunches of it, which, after drying, they put in their wardrobes for the sake of the scent.

Fig. 45.—ANTHOXANTHUM ODORATUM.

In some grasses the spikelets of the panicle have no stalk, and are then said to be *sessile*, from a Latin word meaning sitting. You cannot have a better example of sessile spikelets than is to be seen in the wheat or barley plant, and if you will compare an ear of wheat or barley with an ear of oats, you will at once understand the difference between sessile spikelets and stalked spikelets. But you must be on your guard respecting such grasses as dogstail, foxtail, and Timothy, in which a careless person might think the spikelets are sessile, though any one who

will take the trouble to strip off a few will find them furnished with short stalks.

Of the British grasses with sessile spikelets, one of the best known is rye-grass, *Lolium perenne*, L. (Fig. 46), and you will find it wherever the land is rich enough to grow it. Hence you will usually find it amongst the herbage on road-sides, where the soil is enriched with the washings and the scrapings from the surface of the road. You can hardly mistake the ear of rye-grass for anything else. The spike-lets you will find are set edgewise on, so that the whole ear looks flattened. If you break away the spikelets one by one, you will notice the zigzag appearance of the stem which carries them—an appearance partly due to the row of hollows in each of which a spikelet rested. The spikelet itself is well worth examining. It is seen to be made up of a number of florets, varying in different plants from half-a-dozen to more than a dozen. At the base of the spikelet, and on the side away from the stem, is a stout, horny, boat-shaped structure, which is called a glume. In most grasses there are two such outer glumes at the base of each spikelet, but in rye-grass there is only one, as, owing to the edgewise attachment of the spikelet, the stem itself takes the place of the other outer glume. On good land the herbage of rye-grass is succulent and abundant, and in rich pastures its glossy dark-green leaves are readily noticed even though no ears may be visible. The polished surfaces of the leaves glisten in the sun. No grass thrives more luxuriantly under the treading and grazing of cattle, and rye-grass is found to form a very considerable proportion of the herbage of our best feeding pastures. Its feeding qualities are excellent, so much so that its seed is very largely sown along with

that of trefoil or sainfoin, to remain for a year or two, and to be cut for green fodder or for hay. To such a mixture as this farmers give the name of "seeds." Thus, rye-grass is useful both for pasture and for hay.

Italian Rye-grass, *Lolium Italicum*, *A.* Br. (Fig. 47), is a larger species than *Lolium perenne*, from which it differs also in being awned—that is, in its florets being furnished with short bristles which impart to the ear a bearded appearance. It sometimes happens that *Lolium perenne* is also awned. Italian rye-grass is only short-lived, and does not last more than one or two years. It is never found in old pastures, and is grown solely for hay, or for cutting as green fodder. It thrives exceedingly well on sewage-dressed lands, sometimes attaining a height of five feet or six feet, or even more.*

Fig. 46.—LOLIUM PERENNE.

Fig. 47.—LOLIUM ITALICUM.

* Instances have been known in which Italian rye-grass has attained

Another grass with sessile spikelets is only too well known to farmers who have to deal with arable land. It is called couch grass, and sometimes squitch, or twitch, its botanical name being *Triticum repens*, L. The panicle of couch grass (Fig. 48) is readily distinguished from that of rye-grass, because the spikelets in couch grass are attached broadside, and not edgewise, to the stem, and each spikelet has two outer glumes, one on each side at the base. We can put these useful distinctions in a brief table, thus :—

Genus.	Attachment of spikelets.	Outer glumes.
Lolium	edgewise	one
Triticum	broadside	two

If you will place an ear of couch grass beside an ear of rye-grass you will at once see these differences. *Triticum repens* has a prostrate stem which creeps just beneath the surface of the ground, and by much branching it forms there a kind of bed or couch from which it gets its name of *couch* grass, whilst the specific name *repens* comes from a Latin word meaning creeping or crawling, or couching. Our word reptile is from the same source. It is one of the worst weed pests of

Fig. 48.—TRITICUM REPENS.

the height of eight feet. I once measured grass grown on the Croydon Sewage Farm which was seven feet nine inches long.—[ED.]

arable land, and when a field becomes badly infested with couch, very expensive operations are necessary in order to get rid of it. Land that is allowed to fall out of cultivation soon gets overrun with couch. It is worth your while to grub up some of the prostrate stems, and to notice their whitish colour, varying to pink and red. The sharp free end is the growing point, but if you cut up a piece of the stem into short lengths and plant them in a flower-pot, you will probably find that they will all grow—at least, every piece that has an "eye" or bud upon it will begin to grow, just the same as would a cutting from a geranium or fuchsia. This will enable you to understand how very difficult it is to eradicate couch from the soil, where it usurps the space that rightly belongs to the crop. You will most likely find the ears of couch grass in the hedgerows of arable fields, and you will notice that the leaves form a very considerable angle with the stem which supports them. Couch grass is a good example of a plant that goes on increasing quite independently of the production of seed, although it will grow from the seed as well as most plants.

Meadow Barley Grass (Fig. 49), *Hordeum pratense*, Huds., has, when in ear, very much the appearance of the cereal barley to which it is closely allied, but it is a smaller plant. The long awns and the sessile spikelets arranged in two rows, one on each side of the stem, render this an easy grass to distinguish. It is not a cultivated grass, as the long rough awns are unpleasant to cattle in grazing. The meadow barley grass is nowhere very abundant, though it occasionally occurs in pastures and hayfields.

A very similar, but somewhat stouter grass, the wall barley, or way bent, *Hordeum murinum*, L., is a weed which

commonly grows by gravelly roadsides. It has no agricultural value (Fig. 50).

The rye-grasses, barley grasses, and couch grass are all alike in that their spikelets are arranged in two rows along the stem.

All the grasses we have up to now talked about, excepting cocksfoot, have the spikelets arranged in a more or less close panicle, or ear, and this you have seen to be the case even where the spikelets themselves are stalked, as in foxtail, Timothy, sweet vernal, and others. But there are many other grasses in which the panicle is said to be spreading, as its branches lie away from each other, as you can see very well in an ear of oats. Let us now study some of these grasses with spreading panicles.

Fig. 49.—HORDEUM PRATENSE.

Fig. 50.—HORDEUM MURINUM.

One of the best known of all the grasses with spreading panicles is the graceful quaking grass,

Briza media, L. (Fig. 51). No doubt you have often seen a bunch of this pretty grass in a vase upon the chimneypiece. Although it is only a weed, and grows usually on poor meadows and heaths, yet it is worth your notice because it shows so well what a spikelet is. Each of those beautiful purplish, nodding, boat-shaped structures is a spikelet, and if you pluck one off you will find it has two outer glumes at the base, between which are embraced from five to ten florets, without awns. The whole plant is small, and throws up but little herbage. Farmers justly regard it as a weed, but it is none the less beautiful and instructive on this account. Do not fail to observe the very delicate branches of the panicle, which are caused to vibrate by the plump spikelets at their ends, very much as the slender twig of a tree is set in motion by the weight of a small bird which rests upon it.

Fig. 51.—BRIZA MEDIA.

The **Oatgrasses** are a pretty group of plants allied to the cereal oats. You probably know that the Latin name for the oat is *avena*, and it has therefore been bestowed by botanists upon the oat-like grasses. You are likely to meet with the following :—

Avena elatoir, L., tall oatgrass.
Avena flaveseens, L., yellow oatgrass.

Avena pubescens, L., downy oatgrass.
Avena fatua, L., wild oat.

There are, in addition, several others, but it will suffice for the present if you can get to know those I have named.

The **tall oatgrass**, or false oatgrass, as it is often termed, is the most common of the oatgrasses, and can generally be found in or near the hedgerows of grass fields. *Avena elatior* gets its second or specific name from a Latin word meaning tall or lofty. The spreading panicle of this grass (Fig. 52) is made up of spikelets, which are pale, or purplish, and always of a shining appearance. The best character of this grass is that afforded by the awn, but you will have to open the spikelet in order to make it out. Inside the spikelet are two florets, and from below the middle of the back of the lower one arises a long awn, extending considerably beyond the end of the floret. The upper floret has a very short awn arising just beneath its tip, and scarcely noticeable. Sometimes, however, this awn of the upper floret becomes as long as that of the lower one, and you should try to find specimens showing both kinds of awn. On certain soils, *Avena elatior* develops a bulb-like growth just above the root, and this variety has received the name of "onion couch." Tall oatgrass is not, as a rule, cultivated in England, though it is grown somewhat extensively in continental countries. It can generally be found in ear from early summer to late autumn. Beauvois gave it the name of *Arrhenatherum avenaceum*, because of several characters in which it differs from the other avenas.

The yellow oatgrass (Fig. 53), or golden oatgrass, as it is also called, is *Avena flavescens*, L., the specific name

being taken from the Latin *flavus*, yellow. This is a very beautiful plant, especially when in flower. It is not a large grass; its leaves are slender, flat, and covered with short hairs, which can easily be seen on holding the specimen up to the light. The panicle is of shining yellow colour, and glitters in the sun. Up to the time of flowering the ear is very compact, and is beautifully shaded with green and

Fig. 52.—AVENA ELATIOR.

Fig. 53.—AVENA FLAVESCENS.

gold, whilst the delicate, silky awns look like streaks of silver. As the flowers develop the whole panicle spreads out into a tree-like form, and it is at this stage that *Avena flavescens* forms one of the most elegant objects in our meadows. When the blooming time is past and the seeds begin to ripen, the panicle closes up again, its lovely colours disappear, and it becomes brown and withered. If, therefore, you were shown three panicles of yellow oatgrass—

one before flowering, one in full flower, and one after flowering—you would at first find it difficult to believe they were all produced by the same plant. This shows how necessary it is you should watch these grasses as they grow in the field, for that is the only true way of learning about them. Everything you read here about grasses you should, therefore, prove for yourself by the careful examination of specimens you have gathered in the field. *Avena flavescens* is in full flower at Midsummer, and it can be found in most meadows and pastures of good quality on dry land. It is of good feeding value, and is regarded by farmers as one of the useful grasses.

Fig. 54.—AVENA PUBESCENS.

Avena pubescens, L. (Fig. 54) the downy oatgrass, is so called because the whole plant is downy or pubescent, owing to the number of fine, close-set hairs. It is found in dry pastures, especially upon chalky soils, but it can only be regarded as a weed grass. As compared with the yellow oatgrass, the downy oatgrass has larger and fewer spikelets, and a more pointed ligule. Thus:—

	Spikelets.	Ligule.
Avena pubescens	Few, large	Long, pointed.
Avena flavescens	Many, small	Short, obtuse.

Another species, the narrow-leaved oatgrass, *Avena*

pratensis, L., has still larger spikelets than *Avena pubescens*, whilst its lower leaves, though harsh and rough, are not hairy.

Fig. 55.—AVENA FATUA.

The **Wild Oat**, or havers,* *Avena fatua*, L. (Fig. 55), is a weed of cornfields. It is a tall stout plant, much like the cultivated oat; it has a smooth stem, hairy at the joints. It is an annual plant, growing from seed each year, and dying on the approach of winter. The spikelets are large, and each floret, besides possessing a long-twisted awn, is furnished with a number of long reddish-brown hairs, with their points directed upwards or forwards. Hence the floret of *Avena fatua* is something like a fisherman's artificial fly, and is sometimes used as such by anglers. If you place one of these florets in the

* Haver is a Scotch name for Oats, and haver-meal for oatmeal, hence also probably "haversack."—[ED.]

palm of your warm hand, you will probably find it writhe or wriggle about, on account of the influence of the moisture of the hand upon the awn, which is very sensitive to changes of moisture, and is therefore described as hygroscopic.

One of the commonest grasses in this country is that known as **Yorkshire fog**, or meadow soft grass, *Holcus lanatus*, L. (Fig. 56). The whole plant has a delicate woolly covering, and up to the time of flowering the panicle remains closed, and is of various shades of colour from greenish to purplish. In this stage bunches are often gathered to adorn the chimneypiece. As it comes into flower the panicle spreads out, and presents a less attractive appearance. Each spikelet contains two florets, but the outer glumes are large enough to embrace and hide them both. This grass does not bear a good character, and it is more abundant in hayfields than in pastures, whilst the best and richest grass lands contain little or no Yorkshire fog. It is a very common species in many water meadows and damp, high-lying pastures. It can be found in ear throughout the summer.

Fig. 56.—HOLCUS LANATUS.

A closely-allied but much rarer species is **the creeping soft grass**, *Holcus mollis*, L. (Fig. 57). To find this you will need to search the hedgerows and waste places, as it does not usually occur in meadows and pastures. It will help

you if you know how to distinguish between this grass and Yorkshire fog. If you hold the panicle of *Holcus mollis* against your dark coat-sleeve, you will find that a short awn protrudes from every spikelet, whereas in *Holcus lanatus* no awns can thus be seen. As a matter of fact, the upper floret of the spikelet is awned in both these species, but in *Holcus lanatus* the awn is so curved that it is not visible unless you pull apart the outer glumes. Another useful distinction is this: *Holcus lanatus* you will find to be equally woolly all over, whilst *Holcus mollis* is more woolly at the joints than on other portions of the plant. *Holcus mollis* is a weed grass. *Lanatus* means woolly, and *mollis* means soft.

Fig. 57.—HOLCUS MOLLIS.

There is a group of grasses called the **Brome Grasses**, all of which are troublesome weeds. There are as many as ten or a dozen different kinds of brome grasses native to this country, and in the following table the commonest of these are named :—

With long awns	*Bromus mollis*, L. . .	Soft Brome.
	Bromus racemosus, L. .	Smooth Brome.
	Bromus sterilis, L. . .	Barren Brome.
With short awns	*Bromus erectus*, Huds. .	Upright Brome.
	Bromus asper, Murr. .	Hairy Brome, Wood Brome.

These brome grasses all have spreading panicles, and

their spikelets are mostly shaped like a lance-head. The

Fig. 58.—BROMUS MOLLIS.

Fig. 59.—BROMUS RACEMOSUS.

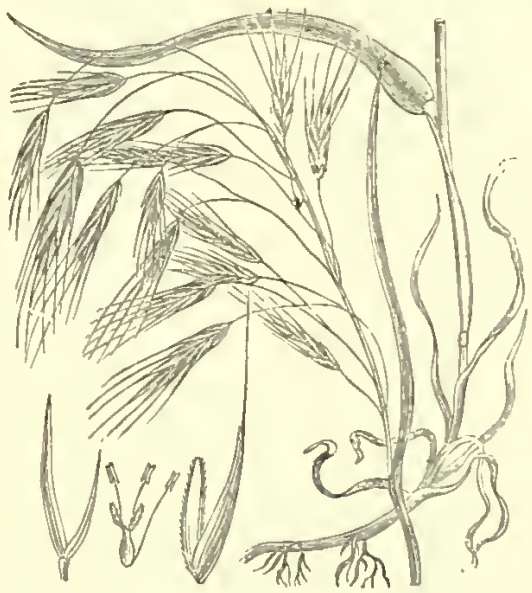


Fig. 60.—BROMUS STERILIS.

spikelets rarely contain less than five or six florets, which

are always awned. *Bromus mollis* (Fig. 58) is perhaps the most familiar of the bromes, as it is commonly found in hayfields, though seldom in pastures. Its spikelets are covered with soft hair, whereby it is distinguished from the similar grass that frequently grows beside it, *Bromus racemosus* (Fig. 59), in which the spikelets are naked. *Bromus sterilis* (Fig. 60) is chiefly a roadside grass, and can

Fig. 61.—BROMUS ERECTUS.

Fig. 62.—BROMUS ASPER.

usually be found beneath hedgerows and fences. The spikelets are darkish, flattened, long-awned, and the margins of the florets are semi-transparent. Despite its specific name of *sterilis*, which means barren, this grass produces abundance of seed. The short-awned *Bromus erectus* (Fig. 61) is chiefly found in fields and waste places on chalky soils. *Bromus asper* (Fig. 62) is the tallest of the bromes, often towering up in the hedgerows to a height of six feet

or more. It has a large drooping panicle with nodding spikelets, and the stem is covered with coarse hairs pointing downwards.

We come now to a group of grasses which, when in bloom, are all much alike (Figs. 63 to 66), the branches of the panicles spreading out in a graceful tree-like fashion. These grasses belong to the *genus* (or race) *Poa*, this being a Greek word meaning fodder, and pronounced as two syllables. There are as many as ten or a dozen species (or kinds) of *Poa* which are native to this country. Those most useful for you to know are—

Poa annua, L., annual meadow grass.
Poa pratensis, L., smooth-stalked meadow grass.
Poa trivialis, L., rough-stalked meadow grass.
Poa nemoralis, L., wood meadow grass.

The first named of these, *Poa annua*, you are sure to know by sight, though you may not have heard its name before. Have you ever noticed a small grass of bright green colour which grows upon gravel walks, and in the corners of gateways, and even upon the very narrow strips of soil between paving-stones, especially in the shadow of a wall? This is the annual meadow grass (Fig. 63), and it can be found in flower nearly all the year round. Gather a specimen—a whole plant—and you will see that near the ground the stems are flattened, the leaves are short and blunt at the ends, whilst the ligule is very long, pointed, whitish, and clasps the stem. You will notice, too, that the whole plant is limp, and very often the leaves are waved. You should look well at the panicle or ear, because it will give you a good idea of what the other species of *Poa* are like.

Fig. 63.—POA ANNUA.

This little grass gets its specific name of *annua* from the fact that it springs up from the seed, produces its own flowers and seed, and dies, all within one year, so that it is an *annual* plant. Wheat, barley, oats, rye, peas, and beans are other examples of annual plants. Some plants are *biennial;* they grow up from the seed during one year, and produce their flowers, fruit, and seed during the next year, and then die, as is the case with parsnips and carrots, mangel and beet-roots, turnips and cabbages. Plants which live more than two years are called *perennial;* Timothy grass and most grasses, besides buttercups, daisies, docks, timber-trees, and many other plants, are examples. It is easy to see that these three words, annual, biennial, perennial, are all built up from the Latin word *annus,* which means a year.

Fig. 64.—POA PRATENSIS.

The small size of *Poa annua*, and the short duration of its life, render it of little or no value to farmers, and it is regarded as a weed grass. It is very seldom found in good pastures, but is more often met with in meadows, especially near the footpaths.

Fig. 65.—POA TRIVIALIS.

The three other meadow grasses that have been named are larger and more robust than *Poa annua*, and as you will see by the illustrations (Figs. 64-66), they are all much alike. Now, though it is not difficult to pick out these larger species of *Poa*, you would at first be a good deal puzzled to know which was which. Yet, if you will only get some thriving specimens and look at their ligules, your trouble will vanish. You have already been told what the ligule is, and you know that in order to see it you have only to bend the leaf-blade

Fig. 66.—POA NEMORALIS.

away from the stem, and where the leaf-blade joins its sheath is the place of the nearly transparent ligule. Now—

In *Poa trivialis*, the ligule is long and pointed;

In *Poa pratensis*, the ligule is short and blunt;

In *Poa nemoralis*, the ligule is absent, or it is so very short that it is not noticeable.

Poa trivialis and *Poa pratensis* may be found in pastures and meadows, and the former grows freely beneath the shade of trees. *Poa nemoralis* is of less common occurrence, and you will need to look for it in woods and copses, and shady hedgerows. *Poa trivialis* is the stoutest and most robust, whilst *Poa nemoralis* is the most slender of these three species. In all of them the spikelets of the panicle vary in colour from greenish to purplish. Besides the difference in the ligule, another good distinction between *Poa trivialis* and *Poa pratensis* is that the former is found to be rough and the latter smooth when drawn through the hand. These two species are both employed by farmers, but the rough meadow grass is the more frequently to be found in rich deep pastures.

Fig. 67.—FESTUCA OVINA.

An important group of grasses are those called the

Fescues. Several of them are very useful grasses, and there are at least two main divisions, which may be called the narrow-leaved fescues and the broad-leaved fescues. They belong to the genus Festuca, and unless care is taken you may mistake some of them for the Poas.

Sheep's Fescue, *Festuca ovina*, L. (Fig. 67), may be regarded as the type of the narrow-leaved fescues. It forms a thick tufted herbage of very fine leaves. The leaves, indeed, are often described as setaceous, from the Latin *seta*, a bristle. This is a very common grass on light limestone pastures and on chalk downs grazed by sheep, and in such localities it helps to form a close carpet of turf. The panicle is not unlike that of some of the meadow grasses belonging to the genus Poa, but you will at once distinguish it by the awns. Sheep's fescue has very short awns, whilst the meadow grasses are never awned. *Festuca ovina* varies very much according to the soil and situation, and botanists recognise several varieties, though you must bear in mind that there are many intermediate forms. The names of these varieties are given in the following table, but at the present stage of your knowledge I will not trouble you with the rather vague and uncertain characters which belong to them.

Fig. 68.—FESTUCA PRATENSIS.

Festuca duriuscula	Hard fescue.
Festuca rubra	Red fescue.
Festuca heterophylla	Various-leaved fescue.
Festuca tenuifolia	Slender-leaved fescue.

Of the broad-leaved fescues, the meadow fescue, *Festuca pratensis*, Huds. (Fig. 68), will serve as the type. It is a smooth green grass plant of moderate size, with a nodding panicle turned to one side. The spikelets are larger than those usually met with in the genus Poa. The leaves are flat and of a rich green colour. Meadow fescue should be looked for in rich moist pastures and meadows. It is a good nutritious grass.

A grass closely allied to meadow fescue, and probably only a variety thereof, is the spiked fescue, *Festuca loliacea*, Huds. (Fig. 69.) It differs from it chiefly in the mode of arrangement of the spikelets which are mostly without stalks, or only furnished with very short ones, so that the plant has considerable resemblance to rye-grass, *Lolium perenne*, and hence its specific name of loliacea. *Festuca loliacea* is an equally desirable grass as *Festuca pratensis*, and may be looked for in the same haunts.

Another species obviously related to meadow fescue is the tall fescue, *Festuca elatior*, L. (Fig. 70), which differs from *Festuca pratensis* in being a larger and more robust plant, often attaining a height of as much as six feet. It also grows on moist pastures and meadows, where it will be found in greatest abundance on the banks of streams, where it gets a footing amongst the reeds and sedges and rushes.

Some of the most delicate and beautiful grasses that grow wild in this country are the Bent Grasses, belonging

to the genus *Agrostis*, which is an old Greek name for grass. The Bent grasses have graceful branched panicles, but the spikelets are exceedingly small, so that a bunch of bent grasses looks like a delicate purple cloud, and they are, therefore, often employed to form an effective background to a nosegay. Some of the bent grasses have very fine, narrow leaves; but these forms are found only upon heaths, moors, and dry downs.

Fig. 69.—FESTUCA LOLIACEA.

Fig. 70.—FESTUCA ELATIOR.

The broader-leaved forms are those which the farmer is most likely to meet with, and of these I will give you some description.

Fine Bent Grass, *Agrostis vulgaris*, With. (Figs. 71 and 72), occurs in meadows and pastures, and sometimes on arable land. It is a poor thin grass, of little agricultural value.

Marsh Bent Grass, *Agrostis alba*, L., is found in pastures and waste places,

and has little to recommend it in preference to *Agrostis vulgaris*. You can distinguish these two species from each other by paying attention to certain characters, which you now well know how to look for.

Fig. 71.—AGROSTIS VULGARIS.

Fig. 72.—AGROSTIS VULGARIS.

Agrostis vulgaris has a short blunt ligule, with smooth sheaths to the leaves, and the panicle remains spreading after the grass has done flowering. *Agrostis alba* has a long pointed ligule, with rough sheaths to the leaves, and the panicle, after flowering, closes up again. Let us put these characters in a table :—

	Ligule.	Leaf-sheath.	Panicle after flowering.
Agrostis vulgaris...	short, blunt	... smooth	... remains open.
Agrostis alba	long, pointed	... rough	... closes.

These grasses are regarded as weeds by the farmer, who

often includes them, with couch grass, under the common name of Twitch, or Squitch.

There is, however, a variety or modification of *Agrostis alba* which, under certain circumstances, may form a very useful pasture grass. This variety is a stouter plant, has larger and broader leaves, and sends out in different directions prostrate stems, to which the Latin name of *stolons* is given. These stolons creep amongst the herbage of a pasture, and wherever a bare space affords the opportunity, they develop rootlets, and so the whole plant spreads with considerable rapidity on a favourable soil. On account of this property, this form of bent grass is known as *Agrostis stolonifera*, L., and it is known to farmers also by the name of Fiorin. It has a larger panicle than *Agrostis alba* (Fig. 73), and the branching of the panicle is very characteristic, there being well-defined intervals between the points at which the clusters of branches arise. Its richer green colour, and its stoloniferous habit, will further aid you in detecting this grass. Sometimes a robust plant of *Agrostis stolonifera* may be found growing as a weed in the rich soil of a kitchen garden. Before leaving the bent grasses, let me caution you not to confuse them with black bent,

Fig. 73.—AGROSTIS ALBA.

which, you will remember, is the name given (page 161) to *Alopecurus agrestis*, a troublesome weed of arable land. There are many notable differences between *Agrostis* and *Alopecurus*.

The **Hair Grasses** are a pretty group of plants, but they must all be regarded as weeds. Half-a-dozen species grow in this country, but as a rule only one of them is met with on the farm. This is *Aira cæspitosa*, L. (Fig. 74), the tufted hair grass, or tussock grass. It grows in wet meadows and pastures, forming dark, unsightly tufts, or tussocks. The leaves are flat, rough, and hard, and cattle seldom touch the herbage. The panicle is, up to the time of flowering, exceedingly beautiful, owing to the brilliant silvery lustre of the purplish spikelets. At the time of flowering, the panicle spreads widely open, and as it does not close again, the effective result of its compact appearance when young is lost. If you know of a pasture a part of which is damp and low-lying, you are very likely to find *Aira cæspitosa* there, and if you notice its graceful, nodding panicle, glistening as the breeze waves it gently to and fro in the June sunshine, you will be sure to remember it.

Fig. 74.—AIRA CÆSPITOSA.

CHAPTER XI.

CLOVERS AND PASTURE PLANTS.

The Clovers and other Pasture Plants.

BESIDES the grasses, there are a large number of plants which are found in permanent pastures. Among these the clovers are the most important, and there are a few plants which, although not strictly speaking clovers, may be classed with them. I shall, therefore, very briefly name and give the general characteristics of this useful group.

Red Clover (Trifolium pratense).

No plant is more familiar than red clover. It is seen growing in all grass fields, whether they are old pastures, or what are called by farmers "seeds," or clover lay. It is often spoken of as broad clover on account of the width of the leaf, and it is called red clover because of its large purple-red flower.* There are two leading varieties of this plant, the first being common red clover, which cannot be relied upon to last longer than from two to three years, and is certainly strongest and most useful during its first year. The other is called perennial red clover (*Trifolium pratense perenne*), or cow grass, and this

* Although the term "flower" is here employed, it is not botanically correct. The head, or, as it is called, the *capitulum* (*caput*, a head), is really an assemblage of flowers, each provided with a corolla and calyx, the whole forming what usually passes under the name of the bloom or flower of the clover.

may be safely introduced into mixtures for permanent pasture. Besides these there is also the zigzag clover (*Trifolium medium*) or marl grass, which appears to be a sub-variety of the same plant. Each of these is familiarly spoken of as red clover, and they form a valuable addition to our grass lands. Common red clover and cow grass are so similar to each other that it is almost impossible to separate them, and the seeds are also so much alike that in buying them we must trust to the seedsmen unless, indeed, we grow the seed ourselves from good and approved stocks. Mr. Sutton says that cow grass "differs from red clover in having a somewhat taller, smoother, and, except in its very young state, a less hairy stem, and a stronger, less fibrous, and more penetrating root. It carries its flowers some way above the foliage, surpasses broad clover in succulence and weight of crop, and stands frost much better." This description shows that it must be difficult to clearly see the difference between the two plants, although their habits are evidently very different.

Common red clover is decidedly the most vigorous and useful of all the *genus*, but its short duration only fits it for forming a part of mixtures intended for one, two, or at most three years. It is also subject to failure on account of what is called clover sickness, which is associated with a certain state or condition of land causing the clover to die away. Clover sickness appears to be due to want of proper food for this species of clover, and when land is naturally or artificially rich in nitrogen the disease may never be noticed. On most agricultural land red clover will not succeed if sown too often, and the land is then said to be "clover sick." It becomes, therefore,

necessary to omit it from mixtures, and to only sow it once in eight, ten, or twelve years, according to the rotation followed.

On well-farmed chalky soils we have known red clover regularly grown every four years without difficulty.

Cow grass is largely used for permanent pastures, and there is also an annual variety of cow grass sold under the name of Imperial cow grass, much used in the south-west of England for cutting for horses as a green food in summer.

White Clover (Trifolium repens).

This is a most widely distributed plant. It is always present, whether on lawns, roadsides, commons, downs, or pastures. The seeds appear to be ever ready to spring up, and it often seems only necessary to manure land in order to bring up a crop of white clover. Even on high-lying heaths it has been noticed that a dressing of lime will bring up white clover, and after lakes or wastes of water have been drained, the appearance of a strong growth of white clover has often been difficult to explain.

The seeds are small, and apparently able to retain their vitality for a long period, and they are doubtless carried by birds, and perhaps by worms or insects.

On examining a pasture closely the white clover may readily be discovered forming an undergrowth of small herbage, which grows rapidly in favourable weather, and yields a capital fodder for all kinds of live stock. White clover is perennial in its nature, and therefore is sown in all mixtures for permanent pasture. No clover is indeed better adapted for this purpose. As its botanical name implies, it is creeping in its habit, and extends from a centre, occupying

the ground in large patches until they meet, and the whole ground becomes covered. The due proportion of clovers to grains is no doubt one of the most important conditions which regulate the value of a pasture or meadow, and the undergrowth of which clover must be considered as exceedingly valuable. The flower is white, and is supported on a long stalk, whereas the bloom of the red clover last described has no flower stalk, the flower being placed between two leaves close to its base.

Alsike Clover (Trifolium hybridum).

Alsike, or Swedish clover, in many respects resembles both the preceding species. It takes its name from the village of Syke or Alsike, near Upsala, and is said to be found growing wild in southern Europe. The flowers are white, but the outer ones are pink, and the head is carried upon a stalk. There are no varieties of Alsike clover. The seed is readily distinguished by its dark-green colour and small size. The duration of Alsike clover is stated to be from three to five years, but is scarcely permanent. When mixed with other plants it may last longer, and it is to be recommended in small quantities in mixtures for permanent pastures. It is most suitable for damp and stiff soils.

Yellow Clover (Medicago lupulina).

This plant is variously known as trefoil, hop-clover, nonsuch, black medick. It is a plant of rather puny growth, but is esteemed for the fine quality of hay which it produces. It is often confused with true yellow clover (*Trifolium filiforme*), but the difference is easily seen after flowering, because while in medick or trefoil the flowers

fall and leave the black fruit full in view, the withered flowers of yellow clover still remain attached and envelop the pod.

Trefoil is generally employed in mixtures meant to last two or three years. It is of short duration, but on warm and dry soils it propagates freely by seeding itself, and hence maintains its place. It is of the greatest use on dry, chalky soils, and is recommended for sowing alone in order to produce an early crop of hay previous to ploughing up for roots. Its growth is scarcely abundant enough for this purpose, and its most useful position is as an ingredient in a mixture of clovers and grains.

Birdsfoot Trefoil (Lotus corniculatus).

This pretty plant is as familiar as any of the preceding, if not more so. It is known popularly as birdsfoot clover, ladies'-slippers and ladies'-fingers, butter-jugs, and shoes-and-stockings. Its bright yellow flowers, variegated with red and rich brown, are always to be observed in summer enlivening a pasture, especially in dry uplands. There are three varieties — known as common birdsfoot trefoil, slender or fine-leaved birdsfoot trefoil, and hairy birdsfoot trefoil. It is an excellent ingredient in mixtures for permanent pasture, as it is perennial in its habit and assists to form a compact sole, or continuous covering to the soil.

Milfoil (Achillea millefolium).

The finely-divided leaf of the yarrow or milfoil is generally to be seen in pastures. Its dark green foliage and dense heads (corymbs) of white flowers are characteristic, but its main feature is its finely-divided leaf, which

may be seen either forming patches, or extensively interspersed with grasses and other plants composing the turf. Milfoil spreads rapidly, and may be sown at the rate of ½ lb. per acre in mixture, but ought not to be too freely employed. It is considered to be nutritious and palatable, and assists to give closeness or sole to a pasture.

Sainfoin (Onobrychis sativa).

This plant is chiefly cultivated upon the chalk and limestone hills of the south of England. It belongs to the same natural order as the clovers, lucern, lupins, vetches; and, like them, appears able to store up nitrogen in the soil. Sainfoin is grown at intervals of from fifteen to twenty years, and is allowed to keep possession of the ground for periods varying from four to seven years. It is a wholesome and excellent sheep food, and makes capital hay. The cultivation of sainfoin resembles that of clover in its being sown upon young barley or sometimes with the barley. It differs from clover in its cultivation by being drilled instead of being broadcasted. The ordinary method is to drill four bushels of the un-milled seed (or seed with the pod or husk adhering) across the barley and then harrowing it in. On the removal of the barley crop the sainfoin is left in possession. It is better not to eat or graze young sainfoin in the first autumn, but to reserve it for mowing the first year. This gives a firm root-hold to the crop, which may afterwards be grazed with sheep. Sainfoin can resist drought better than most plants, as it is furnished with deep roots which draw up sufficient moisture from the subsoil. It may be sown alone, or form

part of a mixture of clovers and grasses in alternate cropping in a five or six years' rotation. Reference to the chapter on rotations will show how sainfoin may be sown after land has been cropped for a series of years, as a means of resting land. The best clover seed is obtained from the Cotswold Hills of Gloucestershire.

Burnet (Poterium sanguisorba).

This plant is often regarded as an impurity of Sainfoin, which it in some respects resembles. Burnet is, however, frequently to be seen on chalky soils, forming a portion of the turf. The fruit of burnet is one of the most common adulterants of sainfoin "seed," but it may be readily detected by its being four-sided, whereas sainfoin is shaped like a double convex lens, or is two-sided. Both are of pale drab colour, and of rough or wrinkled exterior, but the fruit of the sainfoin is covered with honeycombed or reticulated markings. The sainfoin capsule, or fruit, contains one seed, whereas that of burnet contains two seeds. While the two seeds or fruits may be confused together by a casual observer on account of a general resemblance in colour and texture, the instructed eye can at once separate them. In the growing plant the differences are even more marked. In sainfoin the leaflets which form the compound leaf are plain at the margins, while in burnet they are notched or toothed. In sainfoin the flower is of a beautiful salmon colour, and formed upon the ordinary type of the leguminosæ. In burnet there is no conspicuous flower, but a hard greenish head, which could not for a moment be mistaken for sainfoin. Burnet, although often spoken of as a weed, is no doubt a useful ingredient of

grazing grounds when it occurs upon the higher and drier calcareous soils.

We have by no means exhausted all the ingredients which might possibly be found in a square foot of an ordinary pasture. As forty-five species have been described, all of which are to be commonly found, and most of which are useful, it will be readily seen that a pasture is a highly complicated assemblage of plants of very different habits and appearance. Besides these, there are a number of plants which may be classed as miscellaneous weedy herbage. Of such are daisies, buttercups, dandelions, the hawk-weeds, bed-straw, thistles, sorrel, cowslips, wild chrysanthemum, camomile, meadow saffron, sedges, rushes, mosses, etc., all of which are to be found infesting rather than adorning our meadows. To enumerate these plants would be a serious task, and involve a somewhat comprehensive digression into the entire subject of British wild flowers and plants. These plants are often signs of bad land and bad management, and, as a rule, the aim of the good farmer is to discourage their growth and stimulate that of the grasses and clovers.

CHAPTER XII.

MAKING AND MANAGEMENT OF PASTURES.

Mixtures of Grass Seeds.—These are very complicated, and can scarcely be understood without a knowledge of agricultural botany. They usually consist of a number of grasses and clover seeds, amounting altogether to about thirty-six pounds per acre in weight, and consisting of varying quantities of the different plants used. The following may be considered as fair specimens :—

A TYPICAL MIXTURE FOR PERMANENT PASTURE.

	lbs.
Cocksfoot grass	3
Dogstail grass	1
Timothy, or catstail grass	2
Sweet vernal grass	1
Sheep's fescue	1
Foxtail grass	2
Yellow oatgrass	1½
Perennial rye-grass (Pacey's)	5
Tall fescue	2
Rough-stalked meadow grass	1½
Cow grass, or perennial (everlasting) red clover	4
White Dutch clover	4
Alsike clover	2
Birdsfoot trefoil	2
Suckling clover	2
Yellow clover	2
Yarrow, or milfoil	0½
	36½

GRASSES AND CLOVERS FOR PERMANENT PASTURE ON LIGHT SOILS.

	lbs.
Anthoxanthum odoratum (*Sweet Vernal*)	0½
Avena flavescens (*Golden Oatgrass*)	0½

Cynosurus cristatus (*Crested Dogstail*)	1
Dactylis glomerata (*Coeksfoot*)	10
Festuca duriuscula (*Hard Fescue*)	2
Festuca elatior (*Tall Fescue*)	2½
Festuca pratensis (*Meadow Feseue*)	4
Poa pratensis (*Smooth-stalked Meadow Grass*)	2
Phleum pratense (*Catstail, or Timothy*)	2
Trifolium hybridum (*Alsike Clover*)	1
Trifolium pratense perenne (*Perennial Red Clover*)	1
Trifolium prat. per. var. (*Late-flowering Red Clover*)	1
Trifolium repens (*White or Dutch Clover*)	1½
Achillea Millefolium (*Yarrow, or Milfoil*)	0½
Lotus corniculatus (*Birdsfoot Trefoil*)	0½
Medicago sativa (*Lueerne*)	2
	32

GRASSES AND CLOVERS FOR PERMANENT PASTURE ON GOOD MEDIUM SOILS.

	lbs.
Alopecurus pratensis (*Meadow Foxtail*)	4
Cynosurus cristatus (*Crested Dogstail*)	0¼
Dactylis glomerata (*Coeksfoot*)	7
Festuca duriuscula (*Hard Fescue*)	1
Festuca elatior (*Tall Fescue*)	3
Festuca pratensis (*Meadow Feseue*)	7
Poa trivialis (*Rough-stalked Meadow Grass*)	0½
Phleum pratense (*Catstail, or Timothy*)	3
Trifolium hybridum (*Alsike Clover*)	1½
Trifolium prat. perenne (*Perennial Red Clover*)	1½
Trifolium prat. per. var. (*Late-flowering Red Clover*)	1
Trifolium repens (*White or Dutch Clover*)	2
Achillea Millefolium (*Yarrow, or Milfoil*)	0¼
	32

GRASSES AND CLOVERS FOR PERMANENT PASTURE ON HEAVY OR WET SOILS.

	lbs.
Alopecurus pratensis (*Meadow Foxtail*)	4
Cynosurus cristatus (*Crested Dogstail*)	0½

Dactylis glomerata (*Cocksfoot*)	7
Festuca duriuscula (*Hard Fescue*)	1
Festuca elatior (*Tall Fescue*)	4
Festuca pratensis (*Meadow Fescue*)	6
Poa trivialis (*Rough-stalked Meadow Grass*)	1
Phleum pratense (*Catstail, or Timothy*)	4
Trifolium hybridum (*Alsike Clover*)	1
Trifolium prat. perenne (*Perennial Red Clover*)	2
Trifolium prat. per. var. (*Late-flowering Red Clover*)	1
Trifolium repens (*White or Dutch Clover*)	2
Achillea Millefolium (*Yarrow, or Milfoil*)	$0\frac{1}{2}$
	34

The grass seeds may be sown in August, but this plan can only be followed when they are sown "without a crop." A more usual plan is to sow them with the grass seed barrow, upon young corn, in the same manner as has been recommended in sowing seeds for one to three or four years. When the corn is reaped the field is already green with the young grasses, which then grow with rapidity and yield a crop of hay or grazing for animals the following summer.

Treatment of young Pastures.—It is well known that when land is first laid down in permanent pasture it frequently yields a heavy crop the first year. The second year the crop is less abundant, and in the third year it still further declines. Perhaps the fourth year is the most trying for a new-made pasture, and after this period it slowly recovers itself, and by the seventh or eighth year it ought to be established. The appearance of the field is, however, still very inferior to that of an old piece of permanent grass, and, in some cases, twenty or more years must elapse before it arrives at the condition which we wish to see. In

other cases the land never takes to grass, and after a number of unsatisfactory years, it is again ploughed up for tillage. It must be the object of every good farmer to shorten this period of probation and to produce good and productive turf as soon as possible.

The difficulty seems to be to produce a thick sward or close "bottom" of grass, in which no bare earth is visible, and the entire surface is completely covered with a continuous "sole" or "skin" of grassy herbage. On examining a good pasture, it will be seen that the clovers and trefoils occupy an important position as a sub-growth, and that the taller grasses rise above them in abundance.

Our object is best attained by the use of large quantities of manure. No kind of crop requires such a rich soil as do pastures and meadows, and, therefore, every opportunity should be taken to nurse and encourage the growth of the grasses. The best applications may be described in homely language as dirt of all kinds, such as road scrapings, ditch and hedge scourings, or parings from ditches and hedges, pond cleanings, and composts or mixtures of dead weeds and soil, and dung. Plentiful dressings of these and similar materials are particularly suitable for newly-made grass land.

The question as to whether the crops should be mown for hay the first year, or grazed by stock, is an important one, but we incline to the latter method, as less exhausting.

It is true that when grass is allowed to grow to its full height, as it does before mowing, the roots become longer and stronger, as there is a proportion between the upward growth of stem and leaf, and the downward growth of roots.

This is known to be the case with clover, which, when mown, leaves the soil richer in root than when closely grazed by sheep.

A newly-made pasture may then be mown, if we are prepared to manure the ground after the removal of the hay crop. But a more excellent way seems to be to allow the grass to grow to a fair height, and then to turn cows or bullocks into the field and let them waste a little food. The waste is more apparent than real, and we shall find the benefit of this treatment in succeeding years. Sheep are not suitable stock for grazing a newly-laid-down pasture, as they are liable to bite too closely, and to injure the development of some of the finest grasses.

No treatment benefits grass land so much as grazing with bullocks, which receive a little oilcake every day. Bullocks do not graze closely to the ground, and the cake more than makes up for any ingredients which they remove from the ground in adding to their own flesh and bones. By following these directions a good pasture may sometimes be formed within two years of the time of sowing it, and it may be relied upon as a source of profit after the fourth year from the same date.

Improvement of Inferior Pastures.

A great deal of poor grass land is capable of improvement. At one time there was a rage for breaking up such lands and converting them into tillage. This was when wheat was dear, and was looked upon as the sheet-anchor of British agriculture. All this has, however, been altered by the great fall in the price of wheat, so that people are disposed to convert their tillage land into pasture. We

now think it better to improve a poor pasture than to plough it up; and hence a few words upon the improvement of such poor pastures may not be out of place.

In some cases drainage is advisable, while in others it is a doubtful improvement. Boggy or rushy land is very useful for summer grazing, and often lets for as much money as sound arable land. Such soils are better left alone. Hill-sides abounding in springs sometimes require draining, but we leave this point open, only drawing attention to it as a possible means of improving pasture land. We may be sure of one thing, namely, that wet land will not pay for manuring, and therefore, if it is not thought wise to drain it, we may rest assured that it is best left alone or in a state of nature, and used simply as a feeding ground for suitable sorts of live stock.

Naturally-drained, sound pastures which suffer from poverty are generally capable of improvement. A heavy dressing of road dirt, chalk, or manure, or all of these ingredients combined, will usually make a rapid change in such pastures. If applied in winter the materials will become tender under the influence of frost, and the field should be chain-harrowed in March, or as soon as the ground is dry enough to spread the dressing, and level the surface. The best implement for the purpose is shown in Fig. 75.

The points which will be noticed in the drawing scratch up the soil and pull out the moss which so often covers poor grass lands. We should next recommend what is known as a "renovating" mixture of grass seeds, containing white clover, perennial rye-grass, and some other good sorts of grass seeds. These renovating mixtures can always be purchased from good seedsmen, who will assist in

advising as to the best sort of mixture for particular soils. This mixture will be distributed over the surface with the ordinary broadcast barrow, and harrowed in by again taking the chain-harrow over them. The compost spread over the field will give a suitable bed for the young seeds, which will quickly germinate. Sheep are often useful for the same purpose, as they tread in and bury the seed by walking about in search of food. Grazing with cattle, especially when the animals are fed with oilcake, in addition to the grass which they pull from the pasture, greatly helps poor pasture,

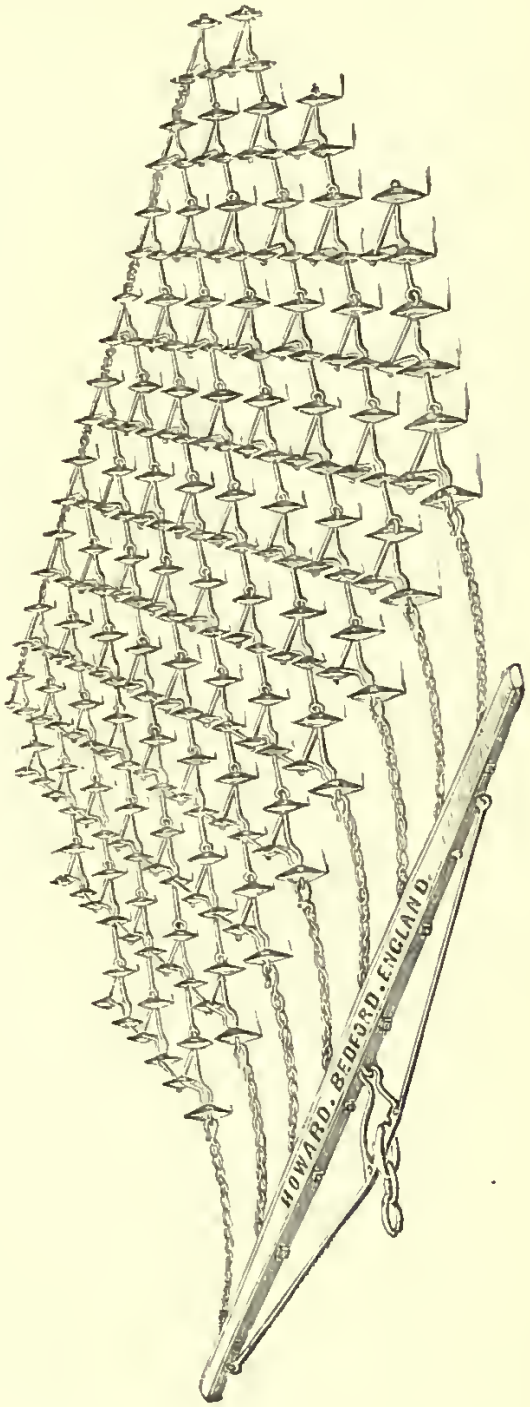


Fig. 75.—HOWARD'S PATENT STEEL CHAIN-HARROW.

and with such treatment we shall find that it alters rapidly into good pasture land.

HAY-MAKING.

Hay-making is one of the most important summer operations on farms. It is always looked upon as a joyous time, and no one loves a hay-field so much as do children. With them it is all fun and frolic, whether tumbling in the hay, or on the top of the rick. With the farmer, however, hay-making is a serious business, and an anxious time, as a change of weather may be the cause of heavy loss to him. Hay-making is easily divided into three parts—1, Cutting; 2, Making; 3, Securing. When to cut, how to make, and how to secure the hay are all points to which our attention must now be directed.

Cutting Grass.—The first question to be decided is when or at what stage to cut the grass? To this question we can give a clear answer, namely, that all grass, clover, and fodder contain the largest amount of valuable matter just when coming into flower. This then is the time to cut—when the clover is in full bloom, and when the grasses are shedding the dust which always comes upon the heads during flowering. A yellow dust covers the boots if we walk through a field ready to cut, and this is the best sign that it is time to begin mowing. I want my readers to see that every day which passes over after this stage has been reached injures uncut grass. Take straw as an example. Green wheat straw is soft, sweet, and easily chewed. Ripe straw is hard, tasteless, and tough. How is this? What change has happened? Take another example. Have you ever noticed that the young shoots of

dogroses, or young leaves of the hawthorn, are sweet aud pleasant to eat? And yet, after a little time, the rose shoots become hard wood, and the hawthorn leaves become tough and tasteless.

The change that has occurred is due to the alteration of the tender cells (cellulose) into woody fibre. It is desirable to cut hay before it turns woody or strawy. Again, the sap of young grass, young straw, aud young wood contains sugar, but in old grass, old straw, and ripened wood the sugar has gone. It too has been changed into indigestible woody fibre, and is no longer preseut as a valuable food. The white appearance of ripe straw or grass is duc to the best parts of it having gone into the seed. It is therefore quite clear that grass ought to be cut when it is iu full vigour of growth, aud this is when it is blooming.

How to cut Grass.—Mowing is as old as Time itself; for has not Time been represented as carrying a scythe over his shoulder? The scythe is still used extensively, but a large and an increasing quantity of grass is now cut by the mowing machiue, a picture of which is given below.

The mowing machine (Fig. 76) is simpler than the reaper, because it is a mere cutting instrument, and is not required to deliver the swathe in sheaves behiud, or on one side, like the reaping machine. There is no doubt that these instruments cut grass quicker and cheaper than can be done by hand labour. Some people would be satisfied that mowing by machine was better than hand labour if they were sure that the work was well and quickly done.

The scythe in the hands of a good workman, however, cuts the grass closer to the ground, and therefore secures a greater weight of hay per acre. It can be used in twisted,

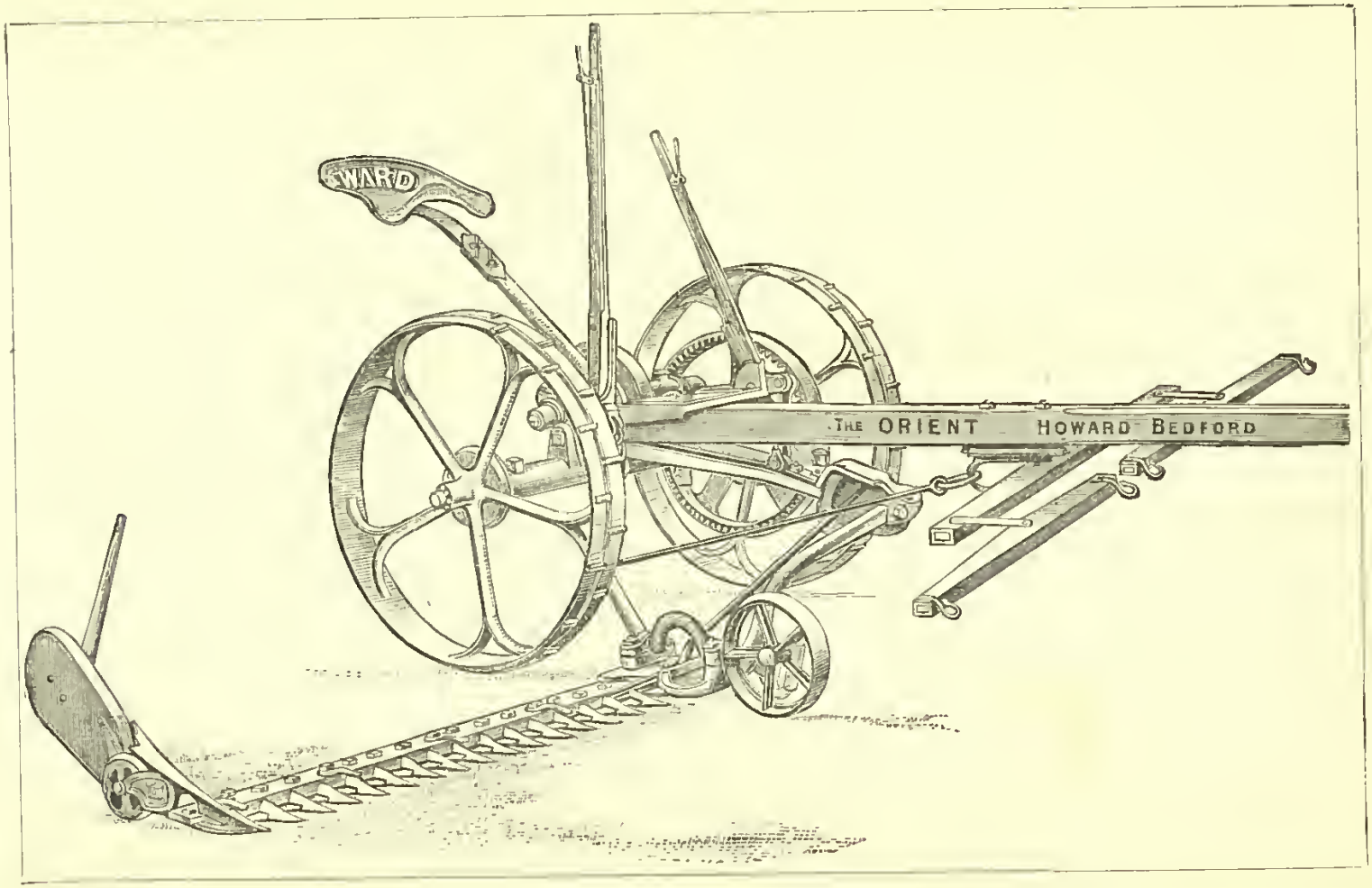


Fig. 76.— MOWING MACHINE.

heavy crops when machinery would be used at a great loss, and hence the scythe is still preferred by many good farmers. Both methods of cutting grass are likely to continue in use for some time longer, or as long as young men continue to learn how to swing the scythe. One of the chief reasons why this older system is likely to die out is because it is difficult to replace our old mowers with younger men. Mowing is very hard work.

What Hay is.—Hay is dried grass. It possesses all the useful qualities of grass, the only element which it has lost being water. As water can always be given separately, we might think that hay and water are as good in all respects as fresh grass. And yet this is surely scarcely the case, for hay cheese—that is, cheese made when cows are getting hay—is inferior to grass-made cheese. So, also, milk and butter from grass-fed cows are always better than milk and butter from hay-fed cows. Grass-fed beef is always thought superior to stall-fed beef. In grass the water seems to be so blended with the other parts of the grass as to give a thoroughly natural food, and hay cannot escape entirely from being an artificial product.

How to make Hay.—Nothing can well be simpler than the process of hay-making. When the weather is fine, it may be said to make itself by giving up its moisture under the influence of the sun and air. Most of the difficulties of hay-making spring from the fact that the weather is uncertain. In showery weather, means must be taken to keep the grass from injury, and the following precautions are all meant to prevent it from being damaged by rain. First, then, we notice that in unsettled weather newly-cut grass is better left just where it fell under the

scythe or the machine. Untouched grass will stand a good deal of rain, but half-made hay is injured much more seriously. Therefore, if a rising barometer shows that a favourable change is approaching, we may as well wait for it before spreading the grass.

Tedding or Spreading.—The first operation consists in what is called tedding. This can be done by hand or by a machine which carries a number of forks upon a revolving drum mounted upon travelling wheels. Fig. 77 gives a picture of this hay tedder. It is useful upon all old meadows, but should not be used in clover hay-making, as it is too rough for the fine leaves of the clover.

Tedding hay by hand requires a good deal of practice before it can be properly done. If an old hand is watched, he will be seen to take up a small quantity of grass from the swathe or row in which it is gathered by the scythe, and shake it up to the wind, separating it as much as possible. It falls to the ground very lightly, covering the whole surface, and dries rapidly. After the grass has been tedded, the labourers return over the same ground and turn it. In this process every piece of hay is lifted by the fork and turned, so as to expose fresh grass to the drying air. If possible, it should be turned once more before evening.

FIRST DAY.

Making Haycocks.—In making meadow hay of the best quality it is best if possible to rake the hay into rows, and break the rows into little round heaps called cocks or kiles, raking up all loose grass between the cocks with a hand rake. This concludes the first day's labour.

SECOND DAY

The next morning the first thing is to throw out the

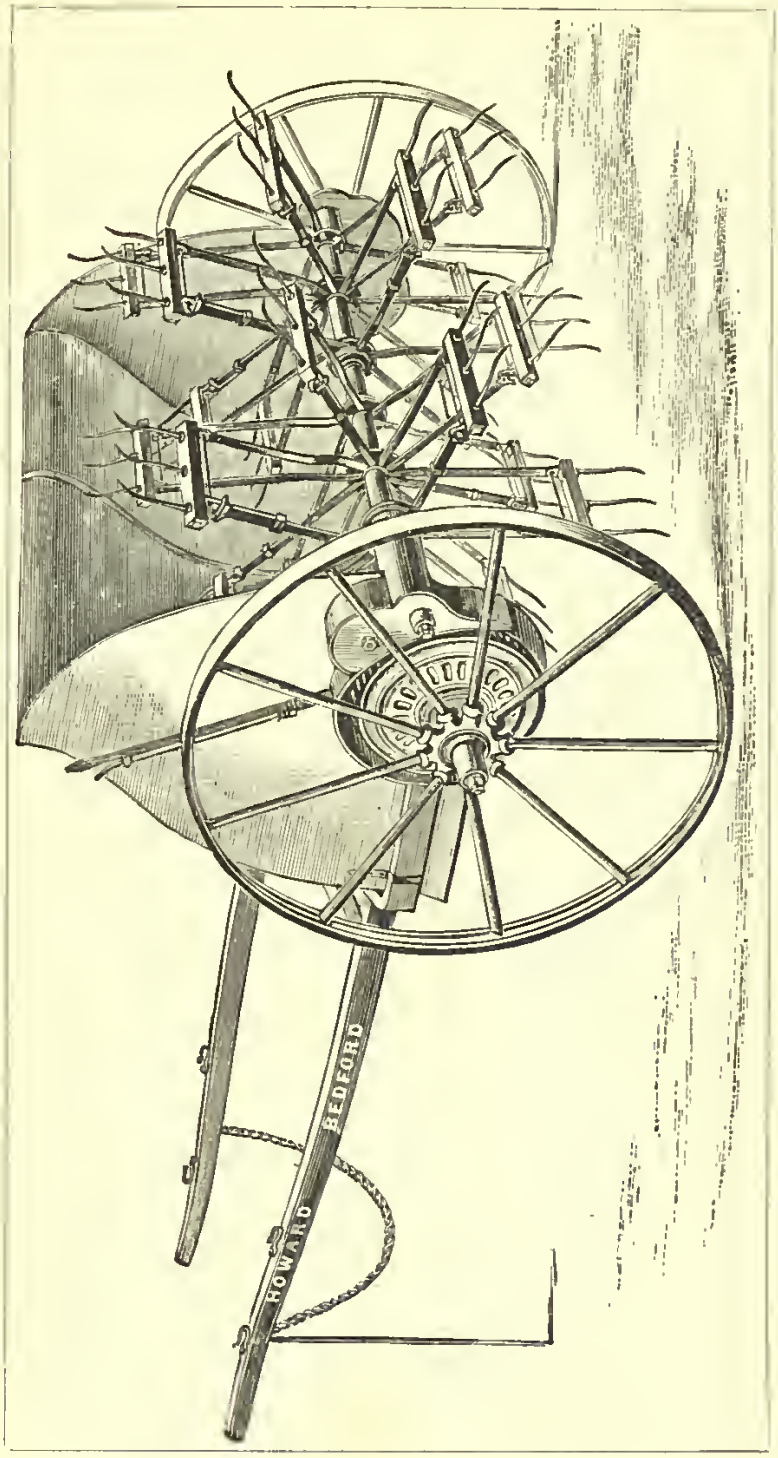


Fig. 77.—HAY TEDDER.

haycocks, spreading them over the ground into what are termed staddles. The labourers then ted the grass which the mowers have mown since yesterday morning. The next thing, turn the staddles, and turn the tedded grass as they did the day previously.

Finally they rake the grass which was in cock the previous night into cocks of double size, and the latest mown grass into grasscocks.

Thus all the grass is got into cock or "off the ground" and is kept free from danger.

THIRD DAY.

This is rather a complicated day, as there are three stages to attend to.

1st—The double-sized cocks which require to be thrown out again into staddles, and turned.

2nd—The grasscocks which want throwing out and turning.

3rd—The latest cut grass which wants tedding and turning.

On the afternoon of this day, the oldest portion which was cut three or four days previously will be ready to take into the rick.

A simpler Account.—As it is not very easy to carry the three stages just described in the memory, I will now ask you to follow one wisp of grass through all the changes suggested. This is the routine through which it goes.

1st day it is mown.

2nd day it is tedded, twice turned, raked together, and made into grasscocks.

3rd day it is thrown out of grasscocks into staddles, the staddles are turned once or twice, and raked together into double-sized cocks.

4th day the large cocks are thrown out into larger staddles, turned and raked together for carting to the rick, or possibly for making into cocks again.

This is what has been often described as Middlesex hay-making, and is the method used for making the best green hay for the London market.

Careless Hay-making.—Too often hay is allowed, in a great measure, to make itself. It is tedded and turned, but the precaution of cocking is neglected. The grass is allowed to lie spread out upon the ground day and night, until it is fit to cart, and it is then pushed into little heaps or "pooks" and taken to the rick. In fine weather this system no doubt answers, but in wet weather it is the cause of a great deal of loss. This book will not have been written in vain, if it assists to spread the practice of making meadow grass into cocks in the process of hay-making.

In the North of England and Scotland, where the weather is more uncertain than it is in the south, no farmer feels happy until he has got all his hay into cocks. The same is true in the home counties, where first-rate hay is required for the London market. It is in the counties where hay is used for home feeding that the greatest carelessness prevails, farmers apparently forgetting that a badly-made, washed-out truss is an inferior food to well-"won" sweet-smelling hay.

How Rain injures Hay.—Most of the valuable parts of hay are easily washed out. This is made clear by taking a wisp of hay, placing it in a bucket, and pouring boiling water over it. The result is a brown fluid which has received the name of hay tea. Cold water will extract the juices in a similar manner, if a little more time be allowed. This, then, is what takes place when half-made hay is allowed to lie abroad over the surface, and is not

made into cocks. No water draws tea so well as soft water, and rain is soft, and it draws the hay just on the same principle as it would draw tea.

When hay has been wet for a few days, it begins to turn black. If we examine the blades and stalks of grass closely, we shall observe that each of them is coated with a sort of crust or rime, which is really a growth of fungus. The hay begins to smell fusty, and when it is cut out of the rick, it will be dusty and fusty, and smell like bad mushrooms. This is as serious an evil as the loss of nourishing parts by washing, already mentioned.

Both of these evils are prevented by getting the hay into cocks as soon as possible, and to "cure in cock" is a maxim well worth remembering.

Labourers who have been accustomed to make hay upon a careless or slovenly principle are difficult to persuade, and even masters sometimes will argue in favour of a method which they have always seen practised. There is, however, no doubt that curing in cock is the only correct way of securing good hay, even when the season is difficult.

Carting Hay to the Rick.—It is important to know when to cart. A very good farmer once replied to the question as to when to cart—"When it is fit." What we want to know is this very thing, and we ask, When is it fit? Perhaps every one does not know that hay may be over-made. This is, however, perfectly true, because hay should heat sufficiently in the rick to get a "good sweating." A "good sweat" makes the hay lie close, and gives a compact heavy truss when it is cut out. Over-made hay comes out of the rick loose and without flavour or aroma. Hay which has heated enough, and not too much, in the rick

becomes brown in colour, and has a rich flavour. If overheated it becomes dark brown, or almost or entirely black, and there is a great risk of the rick taking fire from spontaneous combustion. The hay is also ruined in quality and becomes an unwholesome food for stock. There is evidently then a proper time to cart hay, when it is neither too dry nor yet too moist. A good test is to take a wisp of hay from a cock, or from the ground, and twist it up tightly with both hands. Then unwind the wisp and feel it. If warm and comfortable it is fit to cart, but if this pressure seems to bring sap or moisture to the surface it is not fit. Old men who have been long accustomed to the work will often give a reliable opinion if the master is in any doubt on the subject.

Stacking damp Hay.—As the weather is sometimes very awkward we may find it necessary to cart hay before it is in the best condition. In such cases a layer of dry oat straw between layers of hay may be added to the rick with advantage, and prevent heating by absorbing the surplus moisture. Hay, if slightly undermade, will, when treated as recommended, impart some of its flavour to the straw, and an increased bulk of useful fodder will be the result.

When hay is scarcely in condition it is a common practice to introduce a flue or chimney to carry off the heat and moisture generated in the rick. One of the simplest plans for doing this is to stuff one or two sacks with straw or chaff, and place them so as to divide the rick equally into two or three divisions. The hay is built around the sacks, which are pulled up gradually as the rick rises in height. The result is a round hole reaching

from the bottom to the thatch. The ventilation may be rendered still more effective by placing two hurdles in A form from the hole to the outside of the rick, and thus a circulation of air will be caused which will carry off the heated gases. Iron ventilators have been constructed for securing the escape of heat from a rick, but the plan recommended has the advantages of simplicity, efficiency, and cheapness.

Some years ago there was a movement in favour of fans, which were made to revolve rapidly, and by causing a current of air, to "suck" the hot air out of a rick. It was thought that by means of these fan-blasts grass could be put together wet and dried in the rick. The idea was to draw off the heated and moist air from the rick until no more was given out. In order to do this a flue, connected with the fan, was constructed from the outside to the inside of the rick, close to the ground, and connected with the centre and other parts of the stack. The fan blast was then put in motion by means of an engine, and the hot air drawn out. Like many other fanciful ideas this has now been abandoned, and we hear very little of the patent hay-drier. Mr. Gibbs also has patented an apparatus whereby hay or corn can be dried artificially before it is stacked. This apparatus is not without value, but it has not been generally adopted by agriculturists for assisting them in harvesting their hay or corn. Whether it might be used with advantage is of course an open question, but as even in bad seasons the opportunity for natural air drying generally comes sooner or later, most farmers find it on the whole better to wait for a favourable change in the weather. The principal point which we wish to urge with

reference to both hay and corn is that every precaution should be used in order to prevent wet from injuring them, by conducting harvesting operations carefully, and taking immediate advantage of fine weather to push the work to a successful conclusion.

Building Hayricks.—The building of a hayrick requires some experience in order to keep the sides perpendicular and the corners square. Each rick should also be finished off with a neat sloping roof, which will be conical or ending in a point or dome, in the case of round ricks, and shaped like the roof of a house in the case of long ricks. They are then thatched with straw, and roped securely, to prevent the wind from blowing off the thatch. After a rick is built it settles down, owing to its own weight, and only ceases to do so after the lapse of about two months. When it is settled it will be found to contain one ton of hay to every nine or twelve cubic yards of hay. That is to say, a space three yards long, three to four yards wide, and three yards deep, will contain one ton of hay. A rick ten yards long, seven yards wide, and three yards high, measured to about one foot above the eaves, would contain $10 \times 7 \times 3$ cubic yards $= 210$ cubic yards, or about twenty tons of hay. In measuring hayricks the extreme length, breadth, and height should not be taken, as a fair allowance must be made for outsides, tops, and bottoms. In calculating the contents of a rick by measurement a good deal of judgment and experience are needed.

Clover Hay-making differs from meadow hay-making in some important points. The broad leaves of the clover are liable to become brittle when dry, and to break off and

become lost. It is this peculiarity which makes the difference in treatment between the two sorts of hay. Grass may be tedded and turned with great benefit, and the more it is so treated the quicker it will be in drying. Clover is better left alone after cutting for three or four days, according to the amount of sun and wind. When the upper side is dry it should be gently turned with a rake and allowed to lie for another day or two. Three swathes are then thrown together towards the middle, so as to form a wind-row, and this is broken into cocks, which will quickly become ready for carting.

The horse rake must be considered an important labour-saving machine in the hay or harvest field. The net result of the mowing machine, the hay tedder (only to be used for meadow hay), and the horse rake, is a cheapening of the process much below the cost when hand labour is only employed.

ENSILAGE.

Ensilage is a process by which green clover, grass, or any green crop, such as green oats or beans, may be preserved without drying them. The leading principle of ensilage is the exclusion of air. Pressure, it is true, is considered to be an important thing in making silage; but pressure is only useful because it helps to exclude the air. The silos in use upon Mr. Whitehead's estate at Paddockshurst, Sussex, are air-tight, and when filled they are shut up tightly, and the silage keeps beautifully without pressure.

Ensilage, Silage, and Silos.—When we speak of

Ensilage we refer to the process itself just as we speak of cookery, or the art of cookery. *Silage* is the material itself which comes out of the *silo*, and the silo is the receptacle which holds the silage resulting from the process of ensilage. It is convenient to use these words in the senses given when speaking of the process and product of ensilage.

Ensilage was not known in this country until the year 1875, so that it must be looked upon as one of the newest practices in our agriculture. It is not, however, a new invention, as it has been practised for thousands of years and has been long known to even half-civilised nations in the East.

Ensilage is so simple that it may be understood by anybody. We are all aware that decay or decomposition can be prevented by excluding air. Preserved fruits and meats may be kept fresh for any length of timeif placed in air-tight tins or bottles, from which the air has been driven. Thus, "bottling fruit" is in reality an illustration of ensilage. When brewers' grains are firmly trod into a slate cistern they will keep for a long time, especially if mixed with a little salt, and this again might be compared to ensilage.

When sugar-beet is grown, as in France and Germany, for the manufacture of sugar, the roots are washed and pulped, and the juice is squeezed out by presses. The expressed pulp is then stored in vaults, and made firm by treading, and it keeps during the winter, and is used for feeding oxen. This also is really a process similar to that of ensilage. Grass or green fodder may be treated in the same manner by cutting it into short lengths by means of

a chaff cutter (Fig. 78), and then cramming it into a cemented vault or silo. The chief object is the exclusion of air, and if this object is secured we shall have good silage.

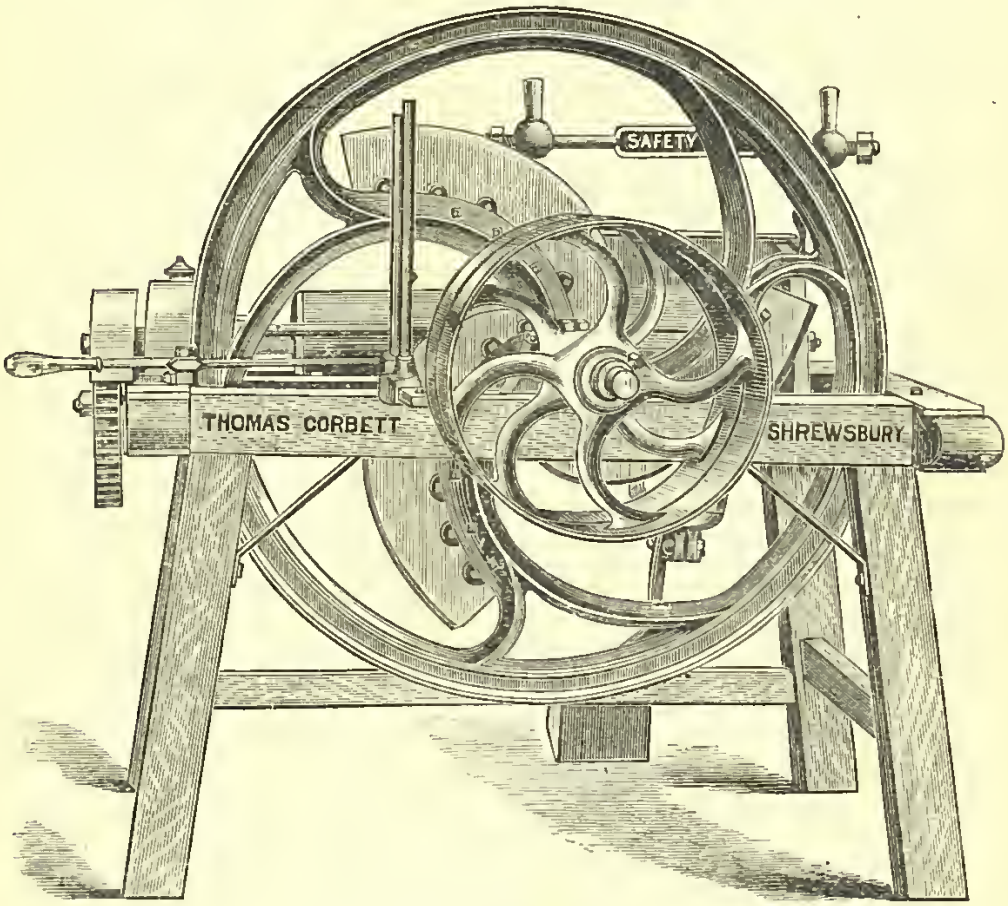


Fig. 78.—CHAFF CUTTER.

Silos should be made of large size, so as to hold a hundred tons or even a larger quautity of silage. Some silos have been built to hold 1,000 tons of silage. You

may always know the amount of silage which a silo will hold by allowing one cubic foot of space for fifty-six pounds of silage after the process is complete. We should therefore require forty cubic feet to hold one ton of silage, and 4,000 cubic feet to hold 100 tons. If we wish to know exactly how large a silo is required for 100 tons, we shall find that it may be, say twenty feet long, twenty feet wide, and ten feet deep = 4,000 cubic feet. That is about as large as a fair-sized room. Many silos are made by digging out or excavating a space twenty feet deep and lining it with bricks, and then coating the sides and bottom with Portland cement to exclude the air and moisture. Such a silo would easily hold 200 tons, and if carried up ten feet above the level of the ground, 300 tons. On many estates the landlords have erected such silos so that the tenants may have the benefit of using silage for the winter feeding of cattle.

Long grass or clover may be preserved without cutting it into chaff, although more care must in this case be taken to tread down the material, especially at the sides and corners of the silo.

A very usual plan is to fix a chaff cutter upon a platform or floor above the silo, and to let the cut fodder fall straight into it, where it is spread about, and well trodden until the top is reached. After two or three days the mass will have sunk sufficiently to make room for another day's filling, and this is repeated until the silo is well and firmly filled. It is then weighted with boards, over which a foot of sand is placed, and the work is complete.

Stack Silos.—Silage may be made in stacks resembling ordinary hay-stacks. The fodder is carted as soon

as it is cut, when fresh and green, to the stack, and is carefully spread upon a level space. It is well trodden, and the carts as they bring the fodder are driven over the stack in the same manner as they are driven over a manure heap. The sides are kept straight or perpendicular, and treading at the outsides of the heap is very important. The stack should be repeatedly or constantly rolled to keep it firm, and the additions of fodder from day to day will also in itself weight the lower sections of the stack. When the stack is considered to be high enough it may be

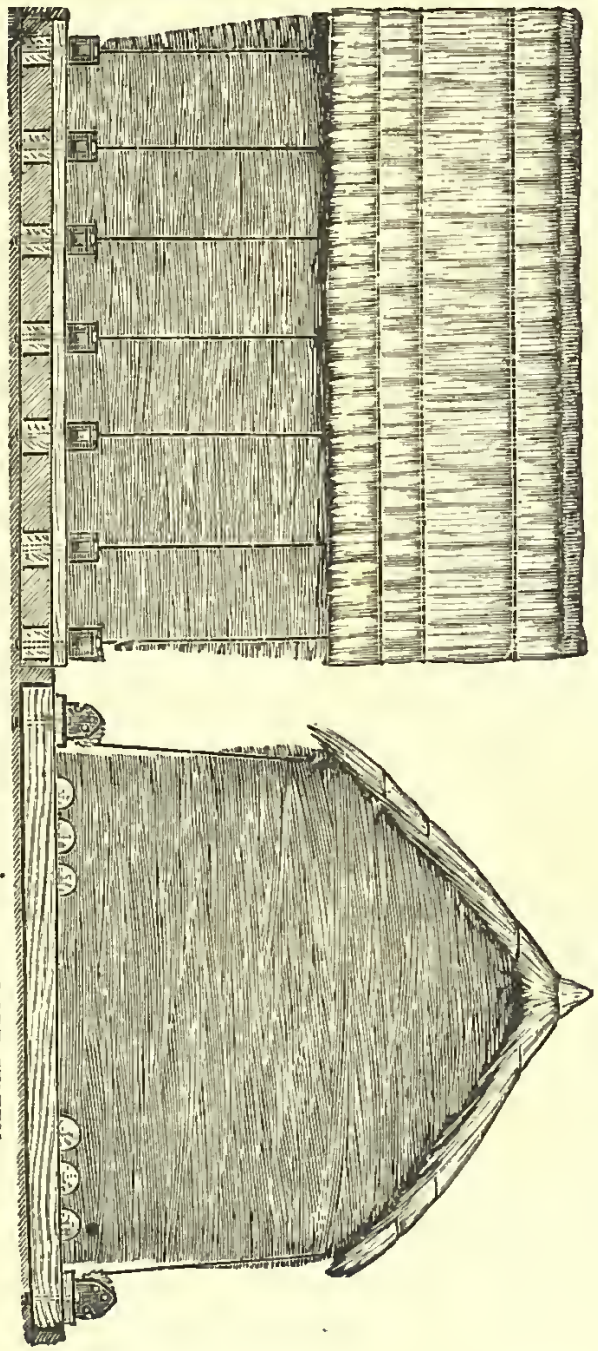


Fig. 79.—SILAGE STACK COMPRESSED WITH JOHNSON'S WIRE ROPE SYSTEM.

trimmed into a neat square form, weighted with timber or earth and thatched, and it will be found useful for the winter feeding of stock.

Wire ropes and mechanical means of pressing silage stacks are now made, and are to be recommended as neater and more precise in their action than the rougher system just described. Fig. 79 shows a silage stack pressed with Johnson's ratchet-drum press by means of steel wire ropes.

Will Ensilage supersede Hay-making?—Probably not. Ensilage will no doubt continue to spread as a system, but it is likely to be carried on side by side with the older method of making hay. When the weather is settled and the barometer high, farmers will favour hay-making, but in wet seasons they should be prepared to make silage. Dry food is always valuable where turnips and other roots are employed, and especially is this true upon sheep farms. On the other hand, silage is a good food for cows when not given in too large quantities, and the butter made from silage-fed cows is better in colour than if made after feeding with hay.

Silage resembles grass more than it does hay, but it is scarcely possible that it should be better than grass. So far as we know at present no artificial food can equal good grass, and we may reasonably believe that those persons are mistaken who endeavour to show that silage is actually better than the green fodder from which it was made.

Sweet and Sour Silage.—There are two kinds of silage, known as sweet and sour. Sweet silage is made by using less pressure and allowing the material to heat up to from 140° to 160° F. Sour silage is made under heavier pressure and a more perfect exclusion of air, and the heat

will range from 100° to 120°F. In silos and silage staeks both kinds, as well as intermediate kinds of silage, will generally be found, aeeording as the degree of pressure has varied. Thus we may expect to find it sour at the lower portions and middle portions of the staek, and sweeter nearer the top and outsides. Both sweet and sour ensilage are good, and there is less loss of weight and of feeding properties in the sour than in the sweet kind of silage.

THE END.

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